

STATE LIBRARY OF PENNSYLVANIA



3 0144 00616854 6

PY G345/1.1



Py G 345/1.1

CLASS ~~P38-38~~ BOOK ~~14~~

VOLUME ~~1840~~

1839

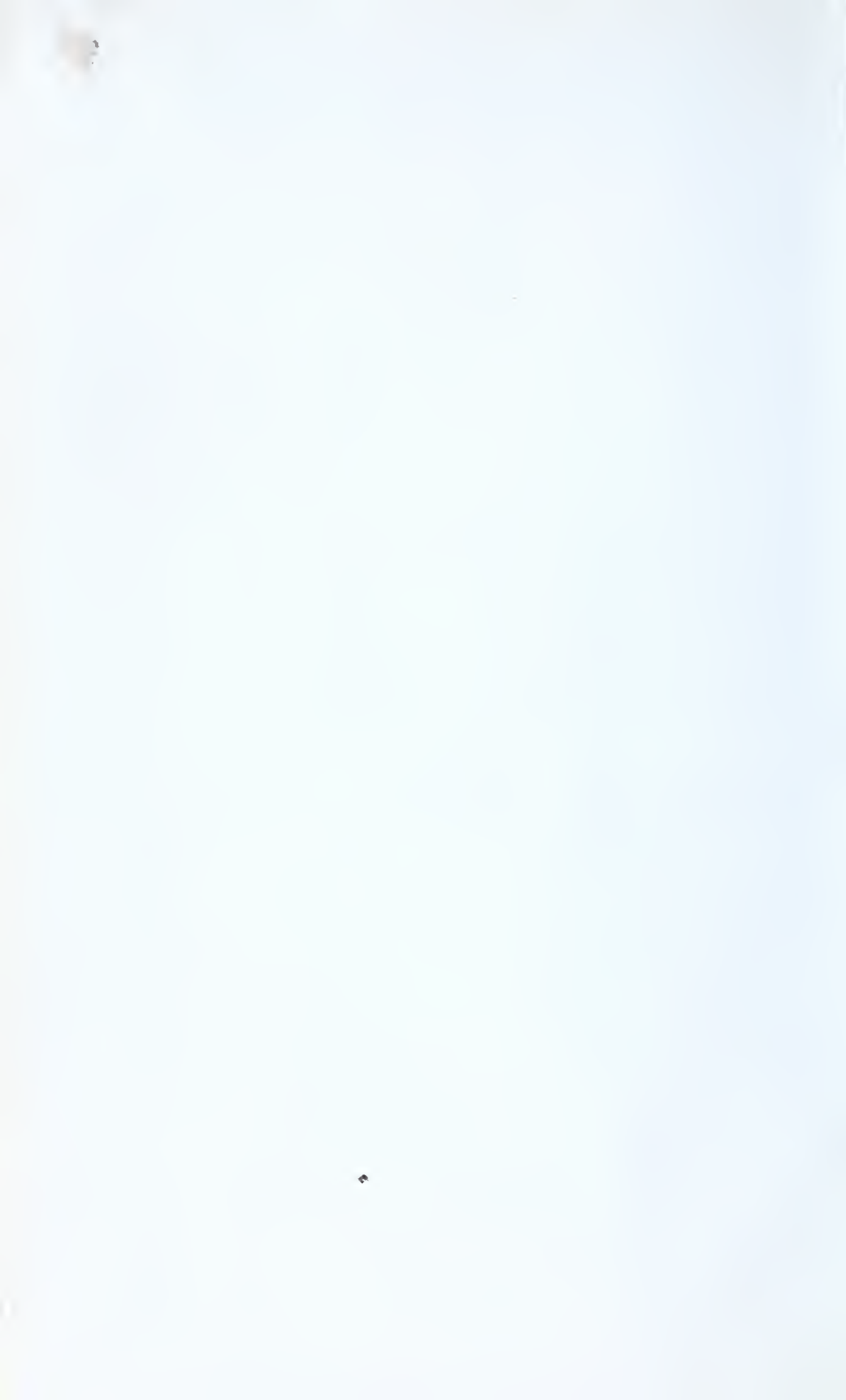
c. 2



PENNSYLVANIA
STATE LIBRARY

Digitized by the Internet Archive
in 2016

PY G345/1.1 1840 Senate



FOURTH ANNUAL REPORT

OHIO

ON THE

GEOLOGICAL SURVEY

OF THE

STATE OF PENNSYLVANIA:

By HENRY D. ROGERS, *State Geologist*.

Printed by order of the Senate, February 8, 1840:

HARRISBURG:
WILLIAM D. BOAS—PRINTER.

.....
1840.

SECRETARY'S OFFICE, Feb. 8, 1840.

Honorable Wm. T. Rogers, Speaker of the Senate.

SIR, I have received the fourth Annual Report of the State Geologist, and have on this day transmitted the same to the House of Representatives, in compliance with the Acts of Assembly upon the subject of a Geological Survey of the State.

I am yours, respectfully,

F. R. SHUNK,

Secretary of Commonwealth.

ANNUAL REPORT
OF THE
GEOLOGICAL SURVEY OF PENNSYLVANIA
FOR THE YEAR 1841

To the Senate of the Commonwealth of Pennsylvania.

In submitting herewith my Annual Report on the Geological Survey to the Legislature, I avail myself of the opportunity to offer a brief statement of the degree of forwardness of the work and the prospect of its early and satisfactory completion.

Though the several acts of the Legislature, making appropriations for the prosecution of the Survey, to continue in force for five years from the commencement, specify no period within which the investigation shall terminate, yet it has been my earnest wish and effort from the beginning to complete the survey as nearly as practicable, in the time to which the present appropriation is limited. I am happy that the advanced condition of the several branches of the work authorize my expressing to the Legislature my confident hope of bringing to a successful close all our researches in the field, by the expiration of the five years mentioned, ending the 1st of April, 1841. I beg leave also to mention my anticipation of being able, during an extra season of six months, with a much diminished scale of appropriation, giving me the aid of a portion of my present corps of assistants, to arrange and bring forward the extensive body of detailed results of the survey in a properly methodized shape. This period of six months will, it is hoped, suffice for the production of my final Report, the completion of the Geological Map of the State, and numerous illustrative drawings, together with an extensive train of chemical analysis of our ores, &c. now going on, and also for the organization of the Geological Cabinet, which will amount, it is believed, to between six and seven thousand specimens.

My present Annual Report, the first in which I have entered into a detailed description of our mineral resources, will, it is hoped, shew the practical direction and bearing of the Survey in all its departments, and by its size, (two hundred and fifty pages,) make manifest the necessity of the six months asked, for the production, in a digested form, of my final Report, embracing all the minutiae of the Survey from the beginning.

With sentiments of great respect,

HENRY D. ROGERS,

State Geologist.

REPORT, &c.

To the Secretary of the Commonwealth.

SIR:—I beg leave to submit to the Legislature, through you, in accordance with my instructions, the following Report of the operations of the Geological Survey of the State, during the past year. In doing this, I shall confine myself, as heretofore, to a statement of the progress which has been made in the several departments of the Survey, and to a general account of the structure and resources of the different districts which have been explored, introducing only such details as are likely to be intelligible, without the aids and illustrations intended to accompany the final minute and systematic description of our Geology. Those illustrations will comprehend the Geological Maps of the entire State and of some of its more intricate regions, the numerous sections designed to exhibit the stratification and position of the mineral deposits in each formation, and an extensive series of detailed chemical analysis, intended to show the true composition and relative economical value of the numerous ores, coals, limestones, cements, clays, building materials, mineral waters, &c. collected in the progress of the exploration.

The active field operations of the Survey were commenced about the middle of April. Pursuing the system of investigation adopted at the commencement of the previous season, examinations were carried on in five of the six districts, into which for convenience sake, as mentioned in my last Annual Report, the State had been divided.

Those members of the corps engaged in exploration, embracing nine Geological Assistants, were distributed over these several divisions in the following manner.

The First district, including all that part of the State lying south and east of the Kittatinny valley, was allotted to Messrs. Holl and Trego; the former aiding me in the exploration of Bucks, Philadelphia, Montgomery, Delaware, and Chester counties, and the southern townships of Lancaster; the latter in the whole of York, and Adams.

In the Second district, comprising the north eastern half of the Appalachian region of the State, including all the country between the South mountain and the Allegheny mountain, and between the Delaware and Susquehanna rivers, terminating on the latter at Muncy creek, I was assisted by Messrs. Whepley and Leslie, the investigations embracing many points of intricacy, particularly in the Pottsville coal basin and the valley north of the Blue mountain.

The task of constructing a detailed map and sections, intended to exhibit, when completed, all the anthracite coal fields of the State, calling for a minute examination of the topography, and an exact tracing, as far as practicable, of every recognizable seam of coal, constituted an important part of the seasons's operations in this district. The resignation of Mr. Whelpley, about the first of July, somewhat retarded the investigations essential to a thorough acquaintance with the highly complicated features and vast mineral resources of these extensive coal fields; nevertheless, I entertain a confident hope of being able to bring this part, together with the rest of the Survey, to a satisfactory termination, in two more seasons, at farthest—furnishing a map and numerous drawings, calculated, it is believed, to prove highly useful to all those in any way interested in the development of the mineral treasures of the region.

In the Third geological district, or that which constitutes the south-western half of the Appalachian region, lying between the Susquehanna river and the southern line of the State, and between the South mountain and the Allegheny mountain, and embracing numerous productive deposits of iron ore and other minerals, together with a valuable coal field, the explorations have been vigorously prosecuted. The detailed examination of the Cumberland Valley and its bounding ridges, devolved upon Mr. Trego, while the exploration of Mifflin, Huntingdon and Bedford counties, together with parts of Union and Centre, was divided between Messrs. M'Kinley, Henderson and Jackson. Mr. M'Kinley devoted himself to a central belt including the Seven mountains, part of Kishacoquillas valley, the whole of Stone valley, and the valleys and ridges from the eastern base of Sideling Hill to Tussey's mountains, closing his operations among the coal seams of Broad Top mountain. The termination of the season, prevented our advancing further towards the south-west. Dr. Henderson gave his attention to the belt of country south east of the last, including the greater part of Mifflin county, and the eastern townships of Huntingdon and Bedford, lying between Sideling Hill and the Tuscarora and Cove mountain. Dr. Jackson took the western portion of the district, comprehending the country situated between Tussey's mountain, and the base of the Allegheny mountain, terminating his operations for the season in the vicinity of Bedford.

In the Fourth district, embracing that part of the State which lies between the eastern base of the Allegheny mountain and the summit of Chesnut Ridge, or the western Laurel Hill, and between the Southern State line and the Bellefonte and Brookeville turnpike, no explorations were undertaken. A laborious and tolerably minute reconnaissance of this wooded region had been made during the previous season, and it was deemed advisable to postpone the examination of its somewhat obscurely developed coal fields until a greater degree of progress should have been made, in ascertaining the true relative situation of the coal seams, beds of iron ore and mineral deposits generally, in other parts of the same great bituminous coal formation throughout the more open country, lying further to the west. By

adopting this order of research, making the better known geology of the vallies of the Monongahela and Allegheny, the key, which it truly is, to the at present, more obscure resources of the district in question, I conceive that the temporary pause in the examination of this district will be productive of increased accuracy in the knowledge we shall acquire of its mineral deposits, and tend materially to expediate this portion of the survey. It is proposed to resume the investigations in this district during the ensuing season with increased facilities for research.

The Fifth district, comprehending all that part of the State lying west of Chesnut Ridge, and the eastern boundary of Armstrong and Venango counties, was entrusted to Messrs. M'Kinney and Ward, who assisted in the exploration of Venango, Armstrong, Butler and a large part of Mercer and Beaver counties, and who were likewise employed in collecting a mass of minute and valuable information along a line of country extending from the base of Chesnut Ridge, through parts of Westmoreland and Washington counties, to the Ohio river at Wellsburg. A detailed section was surveyed along the tract here alluded to; commencing on the turnpike east of Mount Pleasant, following afterwards the Big Sewickly creek to its mouth, and thence crossing from the Youghiogheny to the Monongahela above Williamsport, and following the latter river to the mouth of Mingo creek, and this stream to its source. Beyond this, its direction was north of west through Cannonsburg to Cross creek, and down this stream to the State line and across to Wellsburg. The examinations made along the line here traced, being instituted for the purpose of ascertaining the true positions relatively to each other and to the surface of the adjacent country of all the accessible coal seams and other useful mineral deposits between Chesnut Ridge and the Ohio river, were performed with the aid of instruments designed to impart to the results as great a degree of accuracy as practicable. The elevation of each seam of coal, and the intervals between them, were ascertained for a great number of places along the line of this section by a barometer and barometric thermometer, both of superior accuracy, while the distances between the stations of observation were measured after the usual manner, by the chain and compass. The extensive measurements thus made, enable us to calculate by the information they afford respecting the true dip of the strata, and the undulations of the surface, the depth for any particular spot, along the line of section and over a considerable extent of adjacent country, of every important bed, even when it lies buried under several hundred feet of other strata. By availing ourselves of the data thus collected and instituting when necessary, other similar instrumental measurements across the out crop of the rocks which compose the western counties, we shall give it is hoped to the exploration of the fifth or western district of the State, during the approaching season, as high a degree of accuracy as can be deemed essential for all useful purposes. Pursuing the plan of research thus commenced, it is believed that the coming season will not only bring to light every useful mineral

band in the formation, however unimportant its thickness, whether coal, iron ore, limestone, fire clay or sandstone, but determine with sufficient precision its situation below the surface throughout the whole of the wide region referred to.

In the examination of the Sixth district, which includes the wild and wooded country bounded on the north by the northern line of the State, and on the south by the base of the Allegheny mountain and the Bellefonte and Brookville turnpike, I was aided by Messrs. Hodge and Stone, the latter gentleman, though not a member of the corps, contributing his services as a volunteer for seven months in a remarkably arduous campaign with considerable advantage to the progress of the survey. Owing to the wilderness condition of much of this northern district, it was found indispensable to use a tent, and to aid our operations by employing two men in the duties incident to a camp life.

The business of these persons was to transport provisions, together with the tent and instruments, either on their backs, when it was necessary, as it most frequently was, or with the aid of a pack horse, wherever there was a road. In a region, the geology and geography of which was very imperfectly known, no systematic course of investigation could be pursued, until a certain amount of information was previously collected concerning its local and general features. After an arduous reconnoissance, it was discovered that the coal measures, the principal object of interest in this district, do not form, according to the common belief, one general basin, embracing all the high grounds north of the Allegheny mountain; but occur in a series of small, separate coal fields, confined to the most elevated portions of the region. This important fact being determined, a clue to the position of the coal was soon acquired; saving much labor and time in our subsequent researches. It was soon seen which belts of country demanded a minute investigation, and which authorized a less laborious study. Wherever openings into the coal had been already instituted, or where new ones could be undertaken by ourselves, without too great an expenditure of time, every effort was made to ascertain, as accurately as possible, the number, thickness, and quality of the coal seams, and the order of their superposition. In the wilder tracts of the country, wherever previous research had proved the possibility of the occurrence of the coal measures, a minute inspection of the ground was made; and if any tokens of the existence of a coal bed were noticed, either in the character of the rocks, or in the discovery of the coal slate and smut in the channels of the brooks or in the upturned roots of fallen trees, regular diggings were undertaken, and the position of the coal bed proved. In this way, several seams, hitherto unknown, were developed; and it is believed no important deposit within the region has been passed over undiscovered. That portion of Lycoming county north of the Susquehanna river, between Farrandsville and the Loyalsock, with the exception of a small district bordering this creek—also, the whole of Tioga county, and that part of Clinton county lying on the Tangascootack—have been in this

manner examined, with as close a degree of scrutiny as was compatible with the nature of the country, or usual in researches of this sort. Only a few additional researches, of a general character, remain to be made. A revision of certain parts of the tract thus explored will, it is hoped, establish the true situation of some of the smaller beds found in a few places, about which some uncertainty still prevails, and enable us to complete those observations of the topography requisite to the proper construction of the geological map.

Distributing the investigations in the several districts among the different members of the corps after the manner thus specified, my own duties consisted in superintending the operations in each quarter, either in regular rotation, or in such order as the intricacies and difficulties of the research made most desirable. Directing, and personally sharing in, the operations of the Survey in each district, I am enabled by the above organization to satisfy myself of the accuracy of the observations reported to me, and to contribute, at the same time, my own examinations in aid of those of my assistants in all cases of doubt and difficulty, and to concentrate, if necessary, an extra amount of aid to points which, from their importance and intricacy, require instrumental measurements, or much detailed research.

By adopting the mode thus briefly sketched, and retaining the present organization in the several departments of the Survey, I hope, as each individual in the Survey has now acquired a familiarity with the peculiar structure and local features of the particular district which has been assigned to him, and with the nature of the difficulties to be overcome, to be able to complete nearly the whole of the field investigations, by the close of the next season, leaving but few tracts in the State, of any geological interest, unexplored.

In stating to the Legislature the prospect of so early a completion of the operations in the field, I deem it my duty, at the same time, to mention that an additional season, but probably not an entire year, will be required for finishing various branches of the Survey unavoidably delayed by the active and engrossing duties hitherto essential to the progress of the exploration. For the purpose of revising many intricate portions of the work, where a clue to the stratification has been discovered during the subsequent examinations made in neighboring tracts, and for conducting a number of measurements necessary to the settlement of important practical points remaining still in doubt, this final season will be important. It will be indeed indispensable for the production of the general final Report, and for completing the geological map of the State, and the local maps and geological sections intended to exhibit the situation of the mineral deposits of each district, and for finishing the analysis of a vast number of ores, coals, and other useful substances, collected during the prosecution of our researches.

In the chemical department of the Survey, the analytical operations have been vigorously prosecuted. The Chemical Assistant, Dr. Robert E. Rogers, and Martin H. Boye, having been enabled, by improved arrangements in the laboratory, to perform an extensive

series of valuable analysis, disclosing the chemical composition of many of our ores, coals limestones, and other useful substances, and developing a number of important facts connected with their practical applications in the arts. It is believed, that by the end of the autumn of 1841, contemporaneously with the proposed close of the other departments of the Survey, the chemical work, conducted as at present, will have made known the nature of every material, of any value, within the State, and shown its adaptation to useful purposes. The detailed analysis will, in all, amount to several hundred. By affixing to each specimen examined, a record of its chemical composition, and by placing it in the State cabinet, at Harrisburg, the value of the collection will be greatly enhanced for all purposes.

The specimens collected for the State cabinet during the past year comprising a large body of ores, coals, limestones, cements and other minerals, occupy one hundred and thirty boxes and amount in all to about three thousand pieces. The whole body of specimens hitherto collected during the survey may be estimated at about eight thousand, about four thousand of which, form the contribution hitherto made towards the general State cabinet, which is hoped will ultimately amount to six or seven thousand, and embrace every thing appertaining to our geology and our mineral wealth. The specimens thus far gathered have been opened and temporarily classified and arranged for the purpose of having them as accessible as possible, both for analysis and for reference while framing the annual and final reports on the survey. Upon the termination of the field work, when the collection shall be completed, the requisite analysis performed, and the final report prepared for the press, the whole will be conveyed to Harrisburg, where it is intended permanently to place it for the use of the public. Until then, little advantage, it is conceived, would arise from depositing the specimens in the State Capitol, as they would require to be re-arranged every time an addition were made to their number by the annual gathering, and as they would prove moreover, comparatively useless for reference before the appearance of the final and detailed report, inasmuch as it and the cabinet are designed mutually to elucidate each other.

Should the Geological Survey be completed in the autumn of 1841, as I confidently hope it can be, it will then have occupied five years and a half. The appropriation for the last half year need not I conceive amount to more than five thousand dollars, the operations of the final season admitting probably of such a reduction in the corps, as not to require much more than one half the present scale of expenditure.

CHAPTER I.

Sketch of the Geology and Mineralogy of those parts of the First or South-eastern district, explored during the past season, comprising Bucks, Montgomery, Philadelphia, Delaware, Chester, part of Lancaster, and the whole of York and Adams counties.

The physical feature of the south-eastern district included between the north-eastern base of the South mountains, and the eastern and southern boundaries of the State, are, throughout its southern and central portions, those of a moderately undulating plain, interrupted by few abrupt elevations; while along its northern side we have a broad belt of rounded and swelling hills and ridges some of which attain considerable height.

The rocks comprehended within this extensive area belong, for the most part, to the stratified class; embracing many varieties of both primary and secondary origin. The unstratified rocks of a crystalline structure occur either in the form of small local and irregular veins, or of dykes of greater or less magnitude, intruded through the strata. They include several varieties of *granite*, *sienite* and other similarly constituted rocks, all in thin veins traversing chiefly the primary strata along the southern side of the district, and also, several species of trap rocks, the larger and longer dykes and ridges of which, range principally in the belt of country south of the South mountains and within the Red Sandstone formation. The stratified rocks of the region, occupy a succession of narrow parallel belts, which generally observe a direction from E. N. E. to W. S. W. most of which range entirely across the district from the Delaware river to Maryland. The first of these formations, beginning our enumeration on the south-east, as a broad belt, composed principally of gneiss, mica slate and talc slate and their subordinates varieties which occupy the space between the tide water and the southern margin of the great limestone valley of Chester and Montgomery counties, and its prolongation east and west. To this succeeds the interesting calcareous formation of the valley just referred to, which consists of a more or less crystalline limestone, obviously like the former rocks belonging to a primary date. To the north of the range of this limestone, there occurs, occupying some of the northern townships of Chester county, another large area of gneiss rock. With the exception of this tract, all the formations north of the line in question rank themselves in our Lower and Middle Secondary stata. Thus the sandstone which form the North Valley Hill, Mine Ridge, the Welsh mountain, Chickey's Ridge at the Susquehanna, Milbough Hill, and the hills between Reading and Allentown belong to F. I. of the Lower Secondary or Appalachian series, while the limestone of the central townships of Lancaster county, and of the interior of York county,

refers itself to F. I. of the same group. The red shales and sandstones which traverse the central and northern parts of the district from the Delaware river to Maryland, constitute our middle secondary rocks. These comprise a large part of Bucks and Montgomery, the northern side of Chester near the Schuylkill, the southern townships of Berks, the northern part of Lancaster, the southern side of Lebanon and Dauphin and the northern townships of York, together with a wide tract extending through the centre of Adams.

In presenting a sketch of that large and important part of the district which has been examined during the past year, I propose adopting as far as practicable a uniform order in the description of the several formations, commencing with those on the south-eastern side and advancing successively towards the north-west. The detailed delineations of each belt, as far as this will be attempted, will in nearly every instance be pursued from the N. E. towards the S. W. or longitudinally with the general course of the rocks.

SECTION I.

Gneiss and Mica Slate, with their associated Rocks and Minerals.

The first or south-eastern division of the primary stratified rocks, comprehending the gneiss, mica slate and talc slates situated south of the limestone valley of Montgomery and Chester counties, commences in New Jersey, in a narrow point about six miles to the E. N. E. of Trenton, expanding gradually in its course towards the W. S. W. until it forms a broad belt occupying the whole of the southern townships of Chester, Lancaster and York, where it leaves our State and passes into Maryland. The south-eastern margin of the formation crosses the Delaware at Trenton, where it is well exposed, forming the falls of the river. In this vicinity it consists chiefly of a dark hornblendic gneiss, dipping at a rather steep angle to the S. S. E. Along its course for several miles south-westward, a deep covering of diluvium, conceals a large portion of the belt, and precludes our discovering its local features.

Crossing the Neshaminy about a fourth of a mile south of the road leading from Attleboro to the Buck tavern, in Southampton township, occurs the most eastern exposure of the primary limestone in this quarter of the State. It is in the form of a small oval or lenticular bed, occupying an area not exceeding one half an acre, upon the farm of Mr. Van Arsdale. The bed corresponds in its dip and direction with the strata which surround it. A dyke consisting, chiefly of *Labrador Felspar*, has been protruded through it, and seems to have altered its structure, producing in it, near the line of contact, several minerals, usually foreign to the composition of limestones of this character, such as *graphite* (or *black lead*), *tabular spar*, and *oxide of titanium*, *Actinolite* and *augite*. North-east of the Buck tavern, occurs a dyke of close grained trap. Rather more than a

mile south of the Buck tavern, on the banks of the north branch of the Paquasin creek, there is a locality where Plumbago, or black lead, was formerly worked, but the place is abandoned, and the pit filled up. Near the bridge at Rockville, a granite vein is seen; and in the creek, the gneiss contains several minerals, not unfrequently met with in this locality. Among these are *zircon*, *crystallized oxide of iron*, *dark green, mica* and *blue quartz*. Where the road from Davisville to Huntingdon intersects the county line, there is an extensive *trap dyke*, running nearly east and west, in a straight line; for three miles. The gneiss in its vicinity assumes very much the character of a sienite, and promises, in some places, to be useful as a building stone. A little to the south of this, we encounter the southeastern extremity of a narrow belt of a somewhat peculiar rock, consisting chiefly of felspar, which takes a W. N. W. direction across the old York road, about a fourth of a mile north of Willow Grove, and afterwards conceals itself beneath the overlaying middle, secondary red sand stone. *Zircon*, *titanium*, and *oxide of iron*, are occasionally found in small quantities in the boulders of gneiss and other rocks in the neighborhood of Willow Grove. Included among the hornblendic gneiss of Trenton, and the ordinary granite gneiss and mica slate of the lower part of Bucks and Montgomery, there occurs a somewhat remarkable stratum of felspar rock, well exposed in a quarry on the west side of the Delaware. This material is applicable to several useful purposes, being much employed in Trenton as a flag and curb stone, and furnishing a material much better fitted, by its compact structure, for MacAdam roads, than the softer and more granular rocks which adjoin it. It consists, merely, of felspar and quartz, not separately crystallized, but intimately blended and interfused. It sometimes contains a little talc, together with crystals of *schorl* and *oxide of iron*. Its ordinary color is a light straw yellow. The prevailing dip of the stratum is to the S. S. E., at a steep inclination. Its course is west by south, passing north of Falsington, through Oxford, to Mather's Mill, on the Neshaminy; thence nearly westward, across the road leading northward from Smithfield; after which, entering Montgomery county, it soon begins to expand in width, becoming, when it reaches the Old York turnpike, between Abington and Willow Grove, about a mile and a half broad. About a third of a mile west of the turnpike, it separates into two portions; the northernmost, two thirds of a mile wide, passing westward along the course of Sandy run, and finally disappearing beneath the margin of the middle secondary red sandstone; the southernmost, having a less breadth, taking a S. W. direction, and forming a ridge which skirts the limestone valley, on its south, from this point to the Schuylkill, near Spring Mill, where the stratum at last thins out. A part of this ridge, two miles N. E. of the Schuylkill, is called Barren Hill, where the peculiar rhomboidal structure sometimes seen in the rock is well exposed. In that portion of the formation which passes through Bucks county, several quarries have been opened, the rock being there capable of furnishing a tolerably good curbstone.

The greater portion of the southern and eastern sections of Philadelphia county, shows a deep covering of diluvium, concealing the gneiss and its associated rocks, except where they are exposed in the vicinity of the streams. In this part of their range, the primary strata are much traversed by veins of coarsely crystalized granite, in which the three ingredients, the *felspar*, *quartz* and *mica*, are often of unusual size, the felspar being generally by far the most predominant mineral, and exhibiting a remarkable tendency to pass to the condition of *kaolin*, by decomposition. This rotting, by atmospheric influence, is not confined to the injected veins of granite, but characterizes also a large part of the gneiss, especially in the country around Philadelphia, where the rocks are sometimes in a decayed and pulverulent condition to a depth of more than twenty feet. Advantage is occasionally taken of this circumstance, the loose materials of the rock being sifted to procure a sand which is of remarkable sharpness, and well suited for the purposes of masonry.

At Fairmount, near Philadelphia, the gneiss projects above the diluvium, and is quarried to some extent in this vicinity, and also on the west bank of the river, at Judge Peters's. The grain, or lamination of the rock, is exceedingly contorted; implying the occurrence, at one time, of an immense compressing force. In all the quarries from Fairmount to the Falls of Schuylkill, the rock is intersected by numerous cross joints, which appear, until closely examined, to represent its divisional plains or true stratafications, and which at Fairmount are nearly horizontal. These joints divide the mass into blocks of convenient shape and dimensions; and when they dip in the right direction, greatly facilitate the operations of the quarry. The belt of gray granitic gneiss which passes Philadelphia, is well developed on Darby creek, Crum creek, Ridley creek, Chester creek, and the other adjacent streams. On nearly all of these, it has long been wrought, supplying Philadelphia, and other places, with a large amount of very excellent curbing stone, and material for the foundations of houses and for other purposes. At the Falls of Schuylkill, there is a large quarry of very excellent gneiss, of a light gray aspect, which has long contributed its supply of good building material to Philadelphia. In this quarry is a vein of large grained granite, with red felspar; the strata dip to the N. W. Higher up the Schuylkill, the relative proportion of the felspar in the rock is less, while the amount of mica is greatly augmented. Nearly the whole distance from Fairmount to Manayunk, the prevailing dip of the rocks is towards the north, with only occasional irregularities. Approaching the mouth of the Wissahiccon, *garnets* begin to be abundant; and the rock assumes, for considerable spaces, the composition of a true mica slate. *Staurotide*, *cyanite*, and *red oxide of titanium*, with other minerals, occur in this vicinity.

Near Manayunk the predominant rock is a mica slate. It is much contorted and abounds here and for two miles up the river, as far as the soap-stone quarry in regularly formed crystals of garnet. It is also intersected by numerous veins of coarse *felspathic granite*.

At the tunnel on the Reading rail road, and near the Flat Rock bridge a belt of considerable width crosses the river north of which the mica slate is again repeated, embracing between this point and the belt of soap-stone, one or two smaller zones of the hornblendic rock.

The so called, *soap-stone rock* referred to, crosses the Schuylkill about a mile and a half above the Flat Rock bridge. Its average width is a little more than a furlong. This stratum includes two distinct bands, that on the south being mineralogically a rather peculiar rock, consisting of *steatite* and *talc*, imbedding numerous lumps or knots of dark *serpentine*, while that on the north, is a dark variety of *serpentine* holding occasionally crystals of hornblend. The *steatitic rock* has been quarried for many years on the east bank of the river, supplying Philadelphia to a moderate amount, with a material excellently adapted for the lining of furnaces, grates and fire places. Until the general introduction of marble, it was also used to some extent for the steps of houses, for which, however, it is not so well adapted, the soft steatite being easily worn and leaving in course of time the harder acts of *serpentine* to roughen the surface.

The *steatite* and *serpentine* belt first shows itself near the foot of Chesnut Hill, three fourths of a mile east of the Germantown turnpike. Increasing in width, it crosses the Wissahiccon a short distance below the intersection of the same road where it is well exposed. At this locality it contains *green mica*, *talc*, *steatite*, *dolomite*, *serpentine* &c. in abundance. On the Ridge road, a few detached fragments, in the soil of the neighboring fields, are all that can be found to indicate its course. Approaching the Schuylkill, the *serpentine band* augments considerably in width, forming a distinct ridge which extends into Lower Merion township. At the soapstone quarry on the Schuylkill, the dip of the *steatitic rock*, appears to be parallel with that of the mica slate lying south of it, but it is so much intersected by cross joints as to render it difficult to determine this point with certainty. Between the *steatitic rock* and mica slate there occasionally occurs a thin band having nearly the composition of a chlorite slate. *Crystallized dolomite*, *carbonate of lime* and *talc*, occur here abundantly. About half a mile west of the Schuylkill in Lower Merion township, there is another quarry which has likewise been worked for many years. The *steatite* at this locality can be procured in larger blocks, being less intersected by joints: it frequently contains, however, concretions of *carbonate of lime*, *dolomite* and other minerals which deteriorate its value. About a mile and a half further west, the belt expands to nearly half a mile in width, separating soon into two portions, which cross Mill creek about three furlongs asunder, and then thin out. The *serpentine* throughout the whole range, maintains nearly the same features, being much mixed with heterogenous minerals. No distinct line of division separates it from the *steatite* on its south. North of the *serpentine* range the gneiss again appears, traversed as usual, by veins of granite. Further north, the character of the rock is entirely changed, it having hardly the aspect of a crystalline or primary stratum. This bed is traceable from the river to the Bethlehem turn-

pike. On the west side of the Schuylkill, it forms a high ridge, dividing the gneiss and mica slates on the south, and the talc slate and limestone on the north. Not far west of the river hematitic iron ore exists near it, though not in large deposits, and on the Gulf road ore was worked for some time. Traces of iron ore are frequent in this part of the formation.

Not far from Bellemont the beds of hornblendic gneiss and mica slate contain much injected granite passing to the state of kaolin, one vein of which is from twelve to fifteen feet in thickness. On the Lancaster turnpike about four miles from Philadelphia, there is a locality where it is thought the gneiss might be profitably worked; it was exposed in cutting the new rail road. In the northern part of Blockley township, the hornblendic variety of the gneiss is quite abundant. The townships of Lower Merion, Haverford, Maple, and also the south of Radnor, are composed chiefly of mica slate. In Upper and Lower Providence, Springfield, Darby, Upper Darby, and in Ridley townships, gneiss and mica slate mostly prevail. In the northern part of Lower Merion and Radnor, there is a similar rock to that on the Schuylkill above the serpentine band. It becomes talcose towards Tredyffrin.

On the road from Chester to West Chester, through Edgemont, about three miles from the former place, the beds assume a scientific aspect, a circumstance which is not unfrequent. Its structure implies rather a *metamorphic* than an *igneous* origin. Gneiss and mica slate through which extensive trap dykes have been protruded, are often modified into a rock of similar character.

Near the Blue Hill school house in Upper Providence township, there is a small bed of serpentine, and at the cross roads in Middletown townships, rather more than a mile from Wrangletown, *jasper*, *calcedony*, *flint*, *hematite*, *steatite*, and other minerals occur in the serpentine formation which appears to constitute the hill which crosses the Chester and West Chester road diagonally from S. W. to N. E. The trap dykes that occur in Delaware county are mostly small and rarely influence the strata in their vicinity. One of some size occurs in Newtown.

Near the Spread Eagle, on the Lancaster turnpike, fourteen miles from Philadelphia, there exists a small included bed of serpentine, a little to the north of the main road. No exposures of the rock are visible, but it is distinctly marked by its sterile soil which has caused it to be abandoned by the agriculturist. On the north of this lies the talc slate, which passes so gradually into the mica slate on its southern margin as to render it impossible, unless in particular instances to delineate them separately. The upper or northern margin of the talc slate belt, bounding the primary limestone on the south, is distinctly marked, being generally near the base of the South Valley Hill. This band of primary slates pursuing a W. S. W. direction in the range of hills south of the Great Valley, expands from a width of one mile at its eastern extremity, to a breadth of several miles as it approaches the Susquehanna.

Another bed of serpentine, similar to that near the Spread Eagle, occurs in the mica slates about a mile and a half S. W. of the Paoli, and about one-third of a mile further on in the same direction, there is a large bed of the same rock, nearly two miles in length, which crosses the road from Saugartown to the Warren tavern, and thins out in East Goshen, not far from the township line. North of Saugartown, it has been quarried, furnishing the material for the monument commemorating the massacre of Paoli. In the same range another included bed of the serpentine crosses the road leading from the General Green, to the Steamboat taverns. It is a mile and a half in length, and nearly a fourth of a mile wide. The rock at this locality contains *talc*, *asbestos*, *magnetic iron ore*, *steatite*, and *quartz* and in smaller granules, *amethyst*, *jasper*, *garnet*, *actinolite* and *schorl*. Another and smaller band occurs in a direct line with it, about a mile further west, thinning out at Taylor's mill on York run, where it has been quarried to some extent, supplying the building material for the Episcopal church in West Chester.

Serpentine has generally been ranked by geologists among the unstratified, igneous rocks, few instances being recorded where it assumes a regularly bedded structure; but in the belts above described, there is little, either in its relative position to the adjacent strata, or in the appearance of the rock itself, which imply that it has been intruded in a melted state. Its aspect is that of a strictly laminated rock, the divisional plains conforming to the stratification of the surrounding mica slate. This is particularly conspicuous at the quarry last alluded to. We perceive, moreover, no evidence of any contortion in the neighboring schistose rocks, such as would indicate the protrusion of this material. The mica slates, and included serpentine, all dip at a high angle, towards the S. S. E. In the township of West Goshen, occur *carbonate of magnesia*, *magnesite*, several varieties of *quartz*, *cyanite*, *staurotide*, *asbestos*, *amethyst*, *steatite*, *talc*, and *octohedral crystals of iron*, at several localities, but generally in small quantities. In East Bradford township, a few furlongs west of the forks of the Brandywine, we meet with another bed of serpentine, somewhat more than a mile in length. It is exposed on the road leading from West Chester to Wistar's bridge. Near Strode's mill, there occurs another bed, apparently a portion of a different belt. About two miles north of the forks of the creek, on the road leading from Wistar's bridge to the Gap road, we pass a barren hill, which consists of serpentine; and another tract similar occurs on the road from Marshallton to Trimble's mill.

On the Fork run, a mile and a quarter from its juncture with the Brandywine, exists a small lenticular bed of *limestone*, included among the layers of the mica slate. It does not exceed half an acre in extent; but it is a useful locality, furnishing lime for the neighboring lands. In East Bradford township, besides most of the minerals found in West Goshen, we find *fatid carbonate of lime*, *amethyst*, *zircon*, *brown tourmaline*, *adularia*, *actynolite*, *steatite*, and *lithomarge*. The dip of the rocks on the Brandywine, both in

the talc slates and mica slates, is precisely the reverse of that which they display on the Schuylkill, being generally S. S. E., at a steep angle.

Referring in the next place to some points in the geology of the district, south of West Chester and east of the Brandywine, we may mention the occurrence of an excellent *brickmaker's clay*, worked in the vicinity of that town and at several other places. In Birmingham township, on the farm of Caleb Brinton, one mile west of Dillworthstown, the mica slate contains a small interposed bed of limestone, occupying about one acre. It is quarried, yielding a rock of a coarsely crystalline structure, which produces a very good lime. Some distance south of Dillworthstown, a narrow vein of a superior white felspar crosses the road leading to Wilmington, from which masses of considerable size and purity are obtained. Still further to the south, on the farm of Thomas Bullock, in Delaware county, we find another bed of limestone, somewhat similar to the last, though yielding a material of rather less purity. West of the Brandywine, we find the small lenticular *beds of limestone* becoming more numerous among the primary slates. On the farm of William Harvey, one mile above Chad's Ford, is a fine white limestone, containing crystals of *Brucite*. Another bed is quarried about two miles west of the creek, near the Pennsborough township line. It is somewhat larger than any previously described, and lies in the bottom of a valley. The rock is large grained, partly white and partly speckled by dark mica, or clouded by a little carbon. The bed, and the adjoining strata, dip to the south. According to Mr. Townsend, of West Chester, about four hundred and eighty perches of limestone were quarried in this township during the year 1838. Chrome ore, though only in small quantity, has been found on the farm of Joel Swain. *Arragonite*, *crystallized augite*, *sahlite*, and *sphens* crystallized in augite, were also found in this township. In the adjoining township of Kennet, about thirteen hundred perches are said to have been procured from the quarries of Caleb S. Jackson and Lewis Ganzer; the former situated on Red Clay creek, three-fourths of a mile below Marshall's mill; the other on the Delaware line, on a smaller branch on the same stream. The rock, especially at the latter locality, is coarsely crystalline. At both places it is white, and contains *carbonate of magnesia*.

Another small lenticular bed of limestone is traceable near the meeting house at Kennett's Square, but it is not quarried. A fourth bed, of the same description, crosses the western line of Kennett township, about one mile south of the village. A large quarry exists here, on the farm of J. M. Phillips, the stone yielding an excellent lime. The dip, in all these instances, is towards a point a few degrees east of south. Two narrow bands of limestone, about a furlong apart, occur not far from Barclay's mill, higher up on the same stream. The northern and largest one consists of a firm, white and sometimes bluish limestone, containing carbonate of magnesia. These beds are somewhat contorted. On the farm of Thomas Webb, in this neigh-

borhood, a small body of *chrome ore* has been discovered, several tons only of which have been dug. A large limestone quarry has been opened on the farm of Mr. Logan. It yields a good lime. In East Marlborough township, several interesting minerals were met with. Among these are *zircon*, *basanite*, *fætid felspar*, *beryl*, *epidote*, *tremolite*, and *dialage*, all occurring near Unionville; also, *chromate of iron*, *oxide of titanium*, *iserine*, *spongiform quartz*, &c. in other places. During twelve months, about seventeen hundred and twenty perches of limestone were quarried in this township. In West Bradford township, on the Brandywine creek, near Woodward's mill, the slates enclose a bed of limestone; and in the same range, to the W. S. W. of this, there exists another larger one, which thins out in crossing the road from Downingstown to Marshallton, one mile north of the latter place. Limestone is also quarried near the Poor House, not far from the southern line of the township, where an excellent lime is produced. At this locality, we find *fætid quartz*. Another small band of limestone, occupying perhaps a fourth of an acre, may be seen a little north of this, on the road to Marshallton. During twelve months, about four thousand perches of limestone were quarried in this township.. A dyke of fine grained trap crosses the country east of Marshallton, in a S.S.W. and N. N. E. direction, forming a ridge of rather good soil.

In Newlin township, about five hundred perches of limestone have been raised in one year. This township is rich in a variety of minerals; among which we may enumerate, *precious garnet* in small quantities, *radiated quartz*, *chalcedony*, *agate*, *corundum* (both massive and crystallized); *green tourmaline*, *beryl*, and *sapphire ligeforum*, *asbestos*, *oxide of titanium*, &c.

In East Fallowfield township, near Laurel Forge, occurs a steatite rock, at one time quarried, but now only occasionally wrought. Serpentine, also, occurs on the road leading from Marshallton to Coatsville, near the intersection of a small stream entering the west branch of the Brandywine, a little below the paper mill. Nearly the whole of this township consists of the talc slate formation, which crosses the east branch of the Brandywine above the mouth of Valley creek, and passes through the northern part of West Bradford, and thence expands in width through East Fallowfield into West Fallowfield, where the proportion of mica slate in the rock becomes considerable. On Doe run, in the latter township, there is a large quarry of excellent limestone, near the cotton factory. Though nearly in a line with the bed at Phillips's mill, one-third of a mile distant, it does not appear to be the same. In both instances, the dip is towards the south. The rock is bluish and white. Much limestone exists in this vicinity; and from indications, the beds are probably of some extent, though imperfectly exposed. In West Marlborough, the adjoining township, to the south, about eight hundred and fifty perches of limestone are quarried annually, obtained chiefly on Doe run. About a mile and a half north of Londongrove Meeting House, there is a bed of white limestone, containing in some abundance, a mineral, the

nature of which we have not yet determined. Among the minerals found in West Marlborough are dolomite, fluato of lime, magnesite, scapolite, radiated, crystallized and fibrous tremolite, &c. Limestone occurs in the southern part of the township, on the farm of William Penix, two miles to the north of Chatham. It has received but little attention. About half a mile south of Londongrove Meeting House, there is a small hill, consisting of a sandstone, referable, apparantly, to F. I. of the lower, secondary series. The rock dips to the S. E. and seems to be a small patch of that formation which has escaped denudation. Another hill of the same sandstone crosses the Wilmington and Lancaster turnpike, a little south of Chatham. In this latter tract, which is about a mile long and a fourth of a mile wide, the sandstone dips at an angle of forty-five degrees, to a point a little east of south. The occurrence of F. I. in this insulated position, so far to the south of its general margin, which is along the northern side of the Big Limestone valley, is somewhat remarkable, and implies how extensive was the denudation which removed the lower, secondary strata from the southern belt of the State, which they appear, in part at least, to have covered. Near Chatham, *asparagus stone* (*phosphate of lime*) may occasionally be found, and *oxide of titanium* more frequently. During 1838, the limestone quarried in this township amounted to fourteen thousand six hundred and eighty-four perches. A bed, crossing near the branch of White Clay creek, half a mile from Chatham, is extensively quarried. The prevailing color of the rock is blue, though occasionally it is white. It yields an excellent lime, and appears to cover a considerable area. About a mile south, a bed of the limestone occurs, immediately on the creek at Stephen's mill. It is small, and has not been much worked. Steatite rock exists in the same neighborhood. One mile south of Chatham, there is a small quarry of limestone, of a blue color, on the farm of William Hicks. Fine specimens of *ivory quartz* occur in this locality. A white, and sometimes brownish, granular limestone, often disintegrated, is seen on the farm of Phœbe Morgan, half a mile north of Westgrove Meeting House. A quarry of fine limestone lies further down the stream, near Jackson's mill; and a large quarry on the east branch of White Clay creek, near Avondale. The beds here are thick; the rock close grained, and advantageously wrought, and of a bluish and white color, affording, when burnt, a good lime. Potter's clay abounds in this township; also, a little *iron ore*, and crystallized *red oxide of titanium*. In New Garden township, limestone occurs in several localities. One on the eastern township line, belonging to J. M. Phillips, has been already mentioned. Elfric Wilson has opened one on the road, from the Londongrove Meeting House to the Friends' Meeting House, on the Wilmington turnpike, in New Garden. It is situated in a valley not far from the northern line, on the west side of the road. A very good stone is raised at this quarry, which is of a blue and white color. The beds dip to the south, at a steep angle. Dochrnamon Hill consists chiefly of sienitic rock and mica slate, the latter being sometimes quarried for flag stones. Some

of the gneiss in this vicinity furnishes a good building stone. A narrow belt of limestone, yielding a tolerably good lime, is quarried about three-fourths of a mile south of the above mentioned hill. A bed of rather pure *kaolin*, from which several hundred tons have been procured, occurs on the farm of Samuel Hoopes, in the southern part of the township. It appears to be abundant, but the demand for the article is limited. In this neighborhood occurs *magnesian garnet*. About three-fourths of a mile from the Delaware State line, a bed of limestone was quarried on the farm of Thomas Brown. A section in the quarry shows the limestone in a nearly horizontal position, regularly overlaid by mica slate. It is granular, and liable to disintegrate.

Half a mile lower down on the same stream, a branch of White Clay creek, there exists a bed of impure micaceous limestone; quarried on the farm of Septimus Evans. Some parts of the quarry, however, afford a good material. The Waste Land quarries, so called, in this vicinity; are not much worked—the beds have the usual S. E. dip. A part of the rock is inclined to disintegrate, though the quality of the lime is rather good. The quantity of limestone quarried in this township in twelve months was upwards of two hundred and sixty thousand perches.

In London Britain township, there is an extensive belt of limestone. The rock is bluish and white, lying in thick beds. It is compact and produces a good lime. The whole yields from several adjoining quarries, seventeen thousand perches per annum.

Gneiss and mica slates traversed by occasional belts of hornblendic and sienitic stratified rock occupy the townships of London Britain, New London and the greater parts of East and West Nottingham, Upper and Lower Oxford, Londonderry, &c. The soil in some places is moderately fertile, but when the talc and mica slates prevail, and they constitute the predominate formation, it is not productive. In Londongrove near Morris's mill, a singular hornblendic rock occurs which might pass for a variety or sienite. Near Brown's mill, on Little Elk creek, in East Nottingham, we find the eastern extremity of that broad belt of serpentine rock known as the Pine Barren range. The southern margin crosses North-east creek between the cotton factories and the Maryland line. The northern margin passes almost due westward near Kirk's mill to Carter's mill, on the Octarora creek and thence to the Maryland line, at its intersection with the Conawingo. Chrome ore is found in small quantities in this belt not far from Ramsey's tavern, but not in abundance. It also occurs though not in quantity a mile and a half east of the tavern near a small brook which crosses the state road. By washing the debris which strews the bottom and margin of this stream—much chrome ore in a granular form is collected. Two excavations have been opened for the ore in the Pine Barren at Carter's mill, in West Nottingham, but the mineral was soon exhausted. In this township, during the year 1838, one hundred and fifty tons of chrome ore were procu-

red and about fifty tons in East Nottingham. Its market price is about sixteen dollars per ton.

Some of the more mottled varieties of the serpentine in the former township, are quite compact and susceptible of a polish, promising to be adapted to ornamental purposes. A short distance below Carter's mill on the Octarora, there is a seam of the *silicate of magnesia*, from which in 1838, about eight hundred tons of the mineral were procured, valued at four dollars per ton, at the quarry. It lies in the form of compact veins or lenticular beds, of no great thickness, mixed sometimes with steatite and serpentine, the quantity however, seems abundant. A little higher up the creek a narrow vein has been discovered where the mineral is intermixed with much serpentine and other substances giving it the mottled appearance of a *breccia*. The serpentine belt of this and the adjoining townships contains both steatite and asbestos. The serpentine ridge after crossing the Conewingo, and passing into Maryland, is prolonged in a W. by S. direction crossing the Susquehanna near Fraser's Point, and thence entering Harford county. Near the Octarora, not far from Wood's Fulling mill, Mr. Isaac Tyson has a large chrome pit which has been extensively worked for several years. The mineral does not occur in the form of a regular vein or load, but in bunches irregularly mingled among the serpentine on one side, but somewhat well defined on the other, having a general S. E. underlie or dip. The fragments of serpentine on the surface contain much chrome ore, and this locality promises a supply sufficient for the demand for sometime to come. Chrome ore exists also, though not abundantly, near the Baptist Meeting house, on the Maryland line, where steatite, often containing disseminated ore, occurs in great abundance. Asbestos is also common here. The indications are, that the cromiferous iron ore and other associated minerals exist in many places in the belt where they have not yet been procured.

The principal rock in the southern part of Lancaster county is talc slate. The soil resulting from this formation is generally sterile and unprofitable. On the Susquehanna river, a little above the mouth of Peter's rock, near Peach Bottom ferry, slate is quarried on both sides of the river. The strata dip toward the S. S. E. at an angle of seventy-five degrees; the lines of bedding and of cleavage coinciding. Irregular joints traverse them generally at an acute angle. The slates split with great facility.

Near Snedley's saw mill on Little Conewingo creek, occurs a small bed of serpentine embraced between strata of talc slate and mica slate. On the summit of a hill near the road, chrome ore and silicate of magnesia exist in small quantities. A pit was opened here, but is no longer worked. At the Methodist Meeting house, between Little Britain and Drumore townships, we meet with a small bed of curious felspathic rock analagous to that which bounds the primary limestone near the Schuylkill. It yields a good white clay but not in quantity sufficient to make it an object of importance.

Talc slate constitutes for the most part the rock in Colerain, Drumore, the lower part of Bart and part of Martick townships, being varied by a few occasional belts of mica slate. The soil is therefore poor and the country thinly settled. In Bart township the important limestone belt of the Great Valley thins out. On a line with this limestone is a small lenticular patch of the same rock known as Bears' quarries.

Having now completed the observations at present to be made, respecting that part of the southern primary belt which lies south of the Great Limestone valley, from the Delaware as far westward as the Susquehanna, I shall proceed in the next place to describe the primary tracts, lying north of the same valley, and between this latter river and the Schuylkill, then treat of the Geology of the Great Valley itself and afterwards extend my observations west of the Susquehanna into York county.

Gneiss North of the Great Valley of Chester county.

That part of Chester and Lancaster counties lying immediately north of the Great Limestone valley, is occupied chiefly by stratified primary rocks of the gneiss system. Much of this gneiss is of the granitoid kind, while many beds are hornblendic. The predominant constituent is feldspar, though it presents a considerable variety in its composition. In Chester county, to which these observations more especially refer, it is usually rather coarsely crystalline, but in Lancaster, particularly toward the Susquehanna river, we meet with a larger relative proportion of mica and talc slate, replacing the genuine gneiss.

The junction of these gneiss rocks, with the primary limestone of the valley is concealed by the over lapping sandstone (F. I. of our lower secondary series) which forms the North Valley Hill, from the Schuylkill to the westernmost branch of the Octorara creek. On the north, the gneiss of Chester county passes beneath the middle secondary red sandstone formation from Valley Forge, to the eastern extremity of the Welsh mountain, and on the N. W. beneath the older secondary sandstone of the Welsh mountain itself. Mica and talc slates prevail in much less proportion in this tract than throughout the primary region, already described, lying south of the Limestone valley. In the parts of East Nantmeal, Vincent, Pikeland, Charleston and Uwchland, where the gneiss prevails, its character is very uniform; feldspar, hornblend and quartz, being here the prevailing constituents, and mica relatively rare.

Iron ore has been dug here for several years past in several places, about five hundred tons being annually produced. In Vincent township, about six hundred tons are annually procured. It occurs at many localities east of the Yellow Springs, but no where in apparently large deposits. The composition of the ore found near the Yellow Springs, will appear from the analysis given in Chapter VI.

At Kimberton, on the farm attached to the Academy, and but fifty yards south of the road, there is a very small bed of altered crystalline limestone, consisting chiefly of calcareous spar, including scattered crystals of *plumbago epidate* and other minerals. It seems to have been a small lenticular bed into which a dyke or thick vein of sienite has been protruded, the excessive heat of which, when in a melted state has probably modified the rock to the crystalline structure described.

At another locality further north, near Shuter's mill, on French creek at the margin of the red sandstone occurs another bed, of highly crystalline sparry limestone, similarly affected by a dyke of igneous rock and containing beautiful crystals of *plumbago* and other minerals. The intrusive rock seems to be a species of serpentine. These beds of limestone have been wrought to a very moderate extent, the cost of quarrying them being considerable and the lime though fit for agriculture, being rather too dark for the purposes of the plasterer. The structure and mineral character of this calcareous rock, seem identical with those which characterise the belts of altered secondary limestone, which range so extensively along the southern margin of Kittatinny valley across New Jersey.

Small trap dykes are common in the townships of Vincent and East and West Nantmeal. The two high hills near Warwick Furnace consist of trap—the largest mass of this rock in the township. Nearly two miles below the Yellow Springs, on the road which leads direct to the valley, and on the middle branch of the Pickering, there is another, but much smaller, bed of limestone, which has been altered in a similar manner to those above described. The rock that surrounds it is a kind of sienite, and the limestone is crystallized and contains *plumbago*. A fourth bed of the same species of limestone occurs on a small branch of the Brandywine, one mile and a quarter north-east from the Eagle tavern. Like the others, it has been altered by igneous action, and is coarsely crystallized, and contains *plumbago*. Above the Friends' Meeting House, a bed of a singular, hard, hornblendic rock, crosses the road; appearing, also, on the road leading from the Yellow Springs to the Red Lion, two miles above the latter place. Pipe clay occurs in Uwchland township, in considerable abundance. Graphite is said to occur in West Nantmeal, disseminated through blue quartz, but none was met with.

Iron ore is found at several localities. Near Isabella Furnace, a vein of *titaniferous iron ore* occurs on the farm of Mr. Green, yielding 59.44 per cent. of metallic iron. The titanate acid which it contains, forming a titanate of the protoxide, renders the ore difficult to flux, and consequently the manufacture of iron from it has been abandoned. Large quantities of this ore were taken to the lower part of New Jersey some years since, for the purpose of mixing with the *bog iron ore* of that district, and was worked with some success. Its chemical composition is given in Chapter VI.

A little below Waynesburg, near Felt's mill, there is a dyke of trap, extending in a nearly east and west direction. On the road

from the Mariner's Compass to the United States Arms, one mile south of the Lancaster turnpike, there is a bed of limestone, which may belong to F. II., as it is situated on the margin of a hill of sandstone consisting of F. I. It is not altered: the color of the rock, which is fine grained, is a light blue. The area which it occupies is limited. In this township, fifteen thousand perches of limestone are said to be quarried annually.

In Brandywine, and the greater part of West Caln township, hornblendic rocks are common; but in Sadsbury, in Lancaster county, gneiss, usually the granitic kind, and mica slate, are the prevailing strata.

If we trace the line of junction between the primary rocks and the limestone F. II., we shall find it commencing near the western extremity of the Welsh mountain, on the southern side of the hill, and passing near the Pequea Meeting House, in an undulating line. It crosses the county line between Chester and Lancaster a little above St. John's Church, and then runs south and south-west to join the sandstone of the Mine ridge. Following the foot of the Mine ridge on the north side, it leaves the sandstone after a while, and passes about a mile below Strasburg and on the Pequea creek, where some traces of F. II. are visible along the creek, some distance below the main beds of the limestone, not having been denuded. From thence it continues to Willow Street, and is prolonged to the Conestoga, near Wybin's mill. It follows the creek downwards to Hershey's mill, above Safe Harbour, where it crosses and passes round the east and north sides of Turkey hill, reaching the Susquehanna at Wistler's run. A small isolated patch of secondary limestone F. II. has escaped denudation, on the Little Beaver creek, at Jacob Neff's fulling mill, about two miles from Strasburg.

In Bart township, north of the valley limestone, and between the North Valley and Mine Ridge ranges, which consist of sandstone, the gneiss and mica slate occur, and continue, with some slight variations, to the Susquehanna. Turkey Hill is composed of talc and mica slates, which become the prevailing rocks as we approach the river.

Iron ore occurs on Big Beaver creek, in Bart township, near the mill of A. Bare, at the foot of Mine Ridge. It is an argillaceous ore, situated in detritus that has probably been brought down from the neighboring sandstone hill. Much of this sand and loose matter is intermixed with the ore, which has been worked for many years. Iron ore also occurs and is dug near Shenk's tavern, on the Susquehanna, not far from Stoner's ferry. It is an argillaceous ore, and lies near the side of the hill. It is brought to the river to be transported to other places.

Limestone of the Great Valley.

This belt of limestone, which forms the Great Valley, and extends through the western half of Montgomery county through Chester county and Sadsbury and Bart townships, in Lancaster county, commences about a mile and a half south-west of Willow Grove. Tracing it along its southern margin, we find it entering the north corner of Cheltenham township, crossing the Bethlehem turnpike near the Running Pump tavern, a mile below Flourtown, and thence passing to Spring Mill on the Schuylkill, where it crosses the river and follows Gulph creek, through Upper Merion township, into Chester county. This line, after passing the county line, a little less than a mile south of the Baptist Meeting House, follows the foot of the South Valley hill about the same distance north of Glassley and north of the Paoli, to within a couple of furlongs of the Warren tavern, and from thence half a mile south of the Steamboat tavern, and somewhat more to the north of the Indian King. Near Downingtown, it has decreased much in width, being little more than three-fourths of a mile broad. The line passes about two furlongs south of the town. From Downingtown, the foot of the hill indicates the margin of the limestone, which passes rather less than a quarter of a mile below Coatsville on to Freeman's mill, on Buck run; thence to Cloud's mill, near Philip's tavern, on the Gap and Wilmington turnpike; and to the Octarara creek, near the junction of Cloud's run. In Lancaster county, it follows Cooper's run as far as the dam near the Valley mills, but afterwards continues along the valley a furlong south of the stream. We then trace the same southern margin across the west branch of the Octarara, about a fourth of a mile below Buckman's tavern, and thence to Kunkle's and Eckman's run, at which place the limestone terminates. On Eckman's farm, the line doubles back towards the east, and pursues nearly a straight course, by the Reform Meeting House, to Buckman's tavern; thence running straight to the Octarara, a fourth of a mile above Noble's factory. Its greatest width in Lancaster county is not much more than half a mile. Returning into Chester county, it continues direct to Parkesburg. At Coatsville, it passes one and a half furlong north of the village. Two miles east of Coatsville, the belt widens, and passes a fourth of a mile south of East Caln Church. Still expanding, the northern margin passes one-third of a mile north of Downingtown to West Whiteland township line, where it is within a furlong and a half of the Valley turnpike; and thence continues north-east for about three and a half miles. The width of the limestone, taken along the east township line of West Whiteland, is a little more than two miles; and the northern margin is a nearly straight line from thence to the Valley creek, which it crosses half a mile from its junction with the Schuylkill. As the belt passes into Upper Merion, it is overlaid on the north by the red sandstone—a portion of which jutting out in the form of a loop as far as the King of Prussia tavern, conceals that part

of the formation which lies to the north of Reesville. From thence, the northern line continues direct to within half a mile of Norristown, and turning down towards Swedes' Church, crosses the Schuylkill one mile below the bridge. Doubling south a short distance from the river, it forms, in Plymouth township, another loop, and then crosses the Ridge turnpike at the fourteenth mile stone from Philadelphia, and the Germantown turnpike a little more than a quarter of a mile below the fifteenth mile stone. It then passes into Whitemarsh township, crossing the Wissahiccon at Mather's mill, a short distance below Sandy Run, following the run until it reaches the eastern extremity of the belt in Abington township, near Willow Grove.

That portion of the formation which enters Abington township, is more slaty and fractured than that further to the west, and it also contains, apparently, a larger amount of salica. Those portions of the rock which are exposed, or are nearest to the surface, have in many places undergone partial decomposition, and have the appearance of a white calcareous sand. This sandy aspect of the limestone may be observed in all the quarries in the neighborhood of Sandy Run, and also at many other localities. Mostly, however, unless the rock has undergone partial decomposition, the limestone is crystalline and granular; varying in color from blue to white, as a greater or less amount of carbonaceous matter may enter into its composition. Each of these colors is not confined to a particular stratum, but varies repeatedly in the same bed, and, indeed, the area occupied by one particular color is usually very small. The dip throughout the whole formation is remarkably uniform. Near Sandy Run it is towards the south and S. S. E. Quarries and pits have been opened on almost every farm along Sandy Run. One of the largest in this vicinity is on the farm of Mr. Fitzwater, near Fitzwatertown. The limestone is chiefly blue, the dip S. S. E. at an angle of about sixty degrees. The practice of the landholders is to let out the right of working the quarry for a certain period, and the tenant during that time may excavate as much stone as he may require. Many quarries, also, are opened and worked by the proprietor for his individual supply. No record is, therefore, kept, to enable us to ascertain the number of perches annually quarried.

Near the Meeting House, about a mile above Flowertown, a trap dyke crosses the Bethlehem turnpike in a north east and south-west direction. It is about two and a half miles long, commencing near the north-west line of Springfield township, and ranging past Bickell's mill on the Wissahiccon to the school house lying half a mile further west. The protrusion of the dyke has not disturbed the adjoining strata to any serious extent. A marble quarry has been opened south of the dyke, near Beck's mill. The rock is granular, and its predominant color is bluish. Crystals of *fluete of lime* occur in this quarry. About half a furlong north of the dyke, there is another quarry on Bickell's farm, in which the beds are somewhat contorted.

At the Episcopal Church, near Seller's tavern, the limestone includes a band of stratified felspathic rock similar to that which is

interposed between it and the gneiss bounding it on the south. This bed is small, but forms a steep hill, which crosses the road diagonally. It has the same range and dip as the limestone including it. It separates into small fragments, often rhomboidal in shape, and is used for repairing the turnpike, being quarried for this purpose.

Another band of somewhat similar felspathic rock occurs on Sandy run, near the margin of the red sandstone. It differs from the last in being less readily decomposed and in containing small crystals of hornblend. It is a very local occurrence, only a few layers of it peeping from beneath the overlapping sandstones. The spot is at a smith shop on Sandy run, a mile east of the turnpike.

On the turnpike opposite Sclerstown, a limestone quarry of some size is wrought, the rock making an excellent lime. An extensive quarry of the same, nearly white, variety of the limestone exists on Mather's farm. There, the beds are crossed by very regular joints, giving the appearance of a stratification, in another direction; the true dip is towards the south.

Traces of *iron ore* occur at several localities in Whitmarsh township, but we meet with no deposits of magnitude until we approach Barren Hill and Spring mill. Near the Germantown turnpike, about a fourth of a mile above the Plymouth Meeting House, are the limestone quarries of Wright and Johnson. Much of the stone in this neighbourhood is beautifully white, though some layers occur having a more or less blueish tint. The weathered surface of many beds is rough and sandy, showing some siliceous matter in the rock. At Marble Hall an extensive quarry of white marble is worked by Mr. Hillman. Some of the beds at this place are remarkably white and uniformly crystalline, while others of similar texture are bluish or pinkish and some contain small flames of *green talc*. That portion of the quarry from which the best marble is procured is merely a bed, a few yards in thickness dipping S. S. E. at an angle of eighty degrees. About fifty yards further on, another quarry of very similar marble but of a bluer color is wrought. The beds here are not quite so thick. Near the turnpike, on the farm of Mr. Hilder, small beds of *brown iron ore* have been discovered, from which a moderate quantity has been sent to the Schuylkill to be smelted. The ore is rather too siliceous to yield a good iron, with facility. The deposit extends into the adjoining farm, where a small pit has also been dug. Earthy *plumbago* and *black oxide of manganese* occur in both places mixed with much soil and clay. About a fourth of a mile further down the road, two other marble quarries occur in which the beds are nearly perpendicularly dipping rather towards the S. S. E. These quarries are not so actively wrought as formerly, when blue marble was in more request. Within a few fields of the quarries, a small body of *iron ore* has been found, resembling in most respects that above referred to. This ore is sandy and not well adapted to make a superior iron. *Iron ore* also occurs on both sides of the Ridge road, near the twelfth mile stone and is dug to a moderate amount. This deposit is rather less sandy than that on the Germantown turnpike. A range of calcareous tal-

ose slates, lies in contact with the felspathic stratum of Barren Hill, extending westward, though not with much regularity to the Schuylkill. They pass into a slaty talcose limestone. In many parts of the general limestone belt, the change from compact to slaty limestone arises from the introduction of talcose matter. The compact, thickly bedded white limestone at Spring mill, seems to be a continuation of the talcose beds in contact with the felspathic rock of Barren Hill. Talc slate occupies a band in the limestone, about two miles north of the Barren Hill church.

Iron ore occurs in the neighborhood of Spring Mill and Conshehoken, on several farms. That belonging to Mr. Kuhzey, near the township line has been opened, but to a moderate extent. Nearly all the ore in this neighbourhood is more or less siliceous. For its chemical composition see chapter VI. A quarry of dark blue marble is wrought near the thirteenth mile stone on the Ridge turnpike. In this and another adjoining quarry, the marble is chiefly of the blue variety. The beds dip at a steep angle towards the south, that furnishing the best marble, being sufficiently thick to render the labour of quarrying it less than at some of the quarries already mentioned. A fine natural section along the east bank of the Schuylkill, exposes nearly the whole of this primary limestone belt across its entire breadth. The predominant dip is at an angle of sixty or sixty-five degrees towards the south. From its northern margin for about one mile south, the limestone frequently alternates with thin seams of talc slate and contains thin veins of apparently injected quartz. South of this occur alternating beds of light blue limestone, the change occurring every few yards, until within a mile of Conshehoken, where talc slates begin and extend south to the villiage. At Conshehoken, a trap dyke crosses the river in a E. N. E. and W. S. W. direction, commencing at the Ridge road at the twelfth milestone and extending westward four miles. The talc slate which crosses the Schuylkill near Horry dam, extends along the Gulf run and gradually thins out. Beyond this to the west, the main body of the limestone lies in contact with the talc slates of the southern primary belt which contain no calcareous matter and which form a moderately elevated ridge, extending across the whole of Chester county, separating the calcareous belt from the mica slate still further south. In that portion of the Limestone Valley which occupies the southern part of Upper Merion township, especially in the immediate vicinity of the Schuylkill, there are numerous and extensive quarries, furnishing a large supply of the rock, a portion of which is transported to Philadelphia, and other places, by the several rail roads and the Schuylkill navigation, a large amount being converted into lime on the spot, desigred for the same markets.

A large quarry of the limestone is wrought on the west side of the Schnylkill, two or three miles below Valley Forge, where the rock is tolerably thick bedded and of a light color. The quarried stone is conveyed to the river by a rail road, and thence taken by boats to the various lime kilns. Extensive quarries have also been open-

ed near the Valley Church, where the limestone is very similar to that of the last locality, dipping steeply south, being of a light tint, and furnishing an excellent lime. On the road from Glassley to Valley Forge, near the county line, there is a small bed of slaty, talcose, calcareous rock extending east and west about three furlongs in length towards Valley creek. It constitutes a small hill, over the east end of which the road passes. Near Valley Forge, occurs a stratum of felspathic rock, like that seen at Barren Hill. It is exposed in the creek and occasionally appears emerging from below the sandstone of F. I. at the foot of the North Valley Hill, a little east of the Valley Church. The limestone near the White Horse tavern in East White-land township, is occasionally talcose and slaty. Nearer the Steamboat tavern, the more usual granular structure prevails. Throughout all this range, however, the rock makes excellent lime. A little south of the Valley turnpike about three and a half miles east of Downingtown, is the extensive quarry of superior white marble, which has for many years supplied Philadelphia with the beautiful article, employed in so many of its public and private edifices. It is on the farm of Mr. John R. Thomas. The beds on this quarry are slightly contorted. The portion worked for the marble, separates into two bands. The rock occurs in massive beds, chiefly white, with sometimes a bluish tinge, and is quarried with great facility. It has been much used in the construction of the Girard College, and other public buildings, which adorn Philadelphia and the neighbouring towns. It is valued at about three dollars per cubic foot. This marble is converted into a good lime, but its crystalline or granular structure causes it to crumble in the kiln, making it a little difficult to manage. This variety is much esteemed by masons, being sold in Philadelphia under the name of *Fish-egg lime*, a name suggested by its granular structure. In the year 1838, it is estimated that twenty-five thousand nine hundred and ten perches of limestone were quarried in this township. On the farm of Mr. H. B. Jacobs, there is a quarry of dark blue marble, of excellent quality but the demand for this variety has, of late years, declined. At Downingtown the limestone is chiefly of a light color and compact. Two quarries, one, of a compact, the other of a more granular limestone, have been opened on the farm of Mr. Hunt, who, from some experiments which he has made, gives the preference to the lime made from the granular variety. The analysis given in Chapter VI. will show the relative composition of these two species as they exist in this neighbourhood.

The limestone belt is crossed obliquely by a small *trap dyke*, ranging north-east and south-west, which intersects the rail road near Hunt's farm. The width of the formation, near the East Cain Church, is reduced to about three-fourths of a mile. It is somewhat variable, being dependant, probably, upon the angle of the dip; which, however, is pretty constant. At Coatsville, it does not exceed three furlongs. At Bell's quarry, Midway, the rock is light colored. About a mile east of Trueman's mill, we find a small bed of *white clay*, derived from the decomposition of a felspathic stratum lying between

the limestone and the talc slates. In the vicinity of Buck's run and Parkesburg, the limestone becomes darker and more slaty. In passing Cloud's mills into Lancaster county, it gradually declines in thickness, being at Cooper's fulling mill, in Strasburg township, not more than two furlongs wide. At its termination in Bart township, it becomes more than usually sandy, especially near its margin. The main belt seems to terminate on Eckman's run; but another small lenticular belt shows itself a mile and a half further to the west, on the premises of Mr. Bare, where the rock is quarried.

At Gallagherville, a quarry has been opened upon a vein of crystalline white marble, which promises to afford blocks of building material with facility. The bed is narrow, inclining to the south, at a high angle, and will probably increase in value the deeper it is excavated. Iron pyrites occur in this locality.

Throughout the whole valley, the dip of the formation is very nearly constant, varying usually between sixty and seventy degrees, directed towards the south and S. S. E. Mr. W. P. Townsend, of West Chester, estimates that, in 1838, not less than six hundred and eighty-five thousand two hundred and forty-one perches of limestone were quarried within the limits of Chester county, producing, at the average price of sixty cents per perch, 411,144 dollars; but it is probable that this estimate is somewhat too low.

Of the Primary Rocks in the Southern part of York County.

We shall now proceed to describe the primary strata as they occur along the west bank of the Susquehanna river, where they are well exposed by the excavations made along the newly constructed canal. The rocks near the southern State line are chiefly talcose and micaceous slates, occasionally containing arenaceous bands, approaching in structure to a fine grained sandstone. Near Cooper's Point, occur minute but beautiful crystals of *orthohedral iron*. At the second lock above the State line, we find a siliceous stratum, fifty feet thick, regularly intersected by cross joints, which is extensively used for the construction of the locks and walls of the canal. Slate Point is a high projecting hill, so named from the roofing slate found in it. This slate splits with tolerable regularity, and affords a durable roofing material, but it is difficult to quarry. The chief portion of the slate now procured on the west side of the river, is taken from the same ridge, two miles distant. The completion of the canal will lend importance to this belt of rock. Talc slate is almost the only rock visible from Muddy creek to M'Call's Ferry, a distance of four miles. The dip here is between fifty and sixty degrees toward the S. S. E. In an extensive excavation along the canal, at one place ninety-two feet in depth, we find the purple *sulphrate of copper*, with a little green and blue *carbonate of copper*, enclosed in irregular veins of *white quartz*. On the south bank of Otter creek, one hundred yards from the river, we come upon York Furnace, near which occurs a thin band of limestone, enclosed in talc slate. It is but two feet thick,

the more compact part appearing to be adapted for agricultural purposes. It does not make a good flux for iron ore, being too magnesian.

At Shank's Ferry, the formation embraces a fine grained gneiss rock. Opposite to this, on the eastern side of the river, a bed of limestone occurs, employed as the flux in York Furnace. The ore smelted at this furnace is from the large mine at Chesnut Hill, near Columbia. Above Turkey Hill, we meet with a nearly perpendicular limestone, in the low grounds between the ridge and the mouth of Cabin Branch run. It is much mixed with slate. This calcareous rock terminates in a wedge shaped point, a few miles west of the river. It is not a part of the primary formation, but a prolongation of the lower, secondary limestone of F. II. of Lancaster county. It is quarried at two or the places near Cabin Branch run. About one and a half miles above Burg's mill, we find a bed of the limestone, having the aspect of a very coarse conglomerate, composed of masses of grey limestone, imbedded in a dark slaty cement. This is about one hundred feet thick. Above the mouth of Cabin Branch run, we pass over a broad belt of dark slate, nearly a mile in width. Near its northern margin was seen a large lump of *iron ore* sticking in the bank, though there seems little probability of finding a valuable deposit of the mineral at this place. Dipping under this slate at an angle of seventy-five degrees to the south-east, is a belt of impure slaty limestone, three hundred feet in thickness. This belongs apparently to the alternating rocks at the junction of F. s. I. and II. Its position is about one mile below Wrightsville. A calcareous and arenaceous rock, referable to F. I. extends along the canal about half a mile, terminating near the first lock below Wrightsville. The limestone at the mouth of Cabin Branch run, the prolongation of that of Lancaster county, extends about three miles west from the river, losing itself a little west of Margaretta Furnace, where it is much interstratified with slate. East of the forge, and lying south of the limestone, occurs a compact siliceous and talcose slate, of much beauty, employed for the locks, &c. on the canal. It is more than two hundred feet thick. Margaretta Furnace, two miles from the river, on the Cabin Branch run, is supplied with *ore* from a deposit in its immediate vicinity, which lies near the northern margin of the slaty limestone, near its junction with the slaty sandstone of F. I. The *analysis*, showing the prevailing composition of this ore, will be found in chapter VI.

A somewhat promising locality of roofing slate exists in the Slate Ridge north of the above limestone. It occurs about two miles south of the York and Wrightsville rail road. In a rather wild and sequestered neighbourhood, among the Barren Hills, thirteen miles south-east from York, we come upon Susan Ann Furnace, not recently in operation, but undergoing repairs. The *iron ore* procured near it was found to make an inferior metal, and was abandoned for a purer variety, obtained about seven miles to the west, at a point seven and a half miles south of York, where the mineral occurs, between seams of disintegrated slate, in nests and loose deposits. It is rather

siliceous, but is said to yield a tolerably good iron. Near the Maryland line, at Essex Hall, on the farm of Mr. Clark, a small deposit of iron ore was worked some years ago. In the fields between this and the State line, are found loose crystals of *red oxide of titanium*. At the State line, five miles west of the river, we find a small ridge of serpentine. It is about a mile long, and lies principally in Maryland. In this belt the mineralogist may obtain fine specimens of *green serpentine*, *actinolite*, *chlorite*, and *asbestos titaniferous iron ore*, and *magnetic iron ore*. A band of chlorite slate, near the northern base of the ridge, contains, in abundance, beautiful *octohedral crystals of iron*. Like the serpentine belts of Chester and Lancaster counties, that above described occurs in lenticular form, in the talcose and chloritic slates. Two miles eastward of this point are the slate quarries already noticed as belonging to the ridge which crosses the river below Peach Bottom. The quantity of roofing slate procured here is considerable. Specimens of *Wavellite* are met with in the quarries.

About a quarter of a mile west of the York and Baltimore rail road, and ten miles south of York, a thin band of impure limestone is imbedded in the slate, and quarried on the farm of Mr. Daniel Diehl. Westward from Diehl's towards Jefferson, it is excavated at several localities, and converted into lime for the fields. At Christian Knoll's, east of Jefferson, we meet with indications of iron ore.

The junction of the slate and limestone rocks, F. I. and F. II. is seen on the south of the Pigeon Hills, about four and a half miles north-east from Hanover. One mile south of Hanover, we meet the line of contact between the limestone and slate, ranging north-east and south-west, and passing half a mile south of Littlestown, bringing the margin of the slate to the Maryland line, near Arnold's mill. The limestone belt of the York valley, lying on the north-west of the slate, terminates near this in a wedge shaped point, by the folding round of the overlapping, middle secondary red sandstone, which, after concealing the limestone, encroaches upon the slate.

SECTION II.

Of Formation I. and II., lying North of the Southern Primary Region in Chester, Lancaster, York, and Adams Counties.

FORMATION I.—Sandstone and Slate.

The extensive slate and sandstone formation which constitutes the lowest member of our Older Secondary or Appalachian rocks, has evidently, at one time, overlapped the southern primary belt in a much wider area than that to which it is at present limited. Some further research is requisite in order to determine with precision its true line of junction with the talcose slates west of the Susquehanna. The slaty rocks of the formation approach often so nearly to the character of the primary schists, as to render it somewhat difficult to delineate

their respective limits. The white sandstone constituting the upper division of the formation is everywhere easily recognised. The principal tracts of the formation which have been spared in the general denudation, which has removed so much of the surface rocks in this southern section of the State, are, if we except the more extensive belts of the South mountains, a few insulated, narrow ridges in Chester, Lancaster and York. These form the North Valley Hill, Mine Ridge, Welsh Mountain, Chicques Ridge on the Susquehanna, and the Pigeon Hills in York.

The first of these belts caps the hill bounding the Great Limestone Valley of Chester county on the north, the whole distance from the Valley creek near the Schuylkill, to Bart township, in Lancaster county, forming a long and narrow zone of sandstone resting unconformably near the edge of the limestone and the gneiss. It is nearly of the same width throughout, dipping gently southward. Its prevailing character is that of a more or less granular whitish sandstone.

The next long belt of this formation commences west of the village of Sadsbury, and under the name of the Mine Ridge, passes into Lancaster county terminating on Big Beaver creek. At a gorge in this ridge on the Newport turnpike, the rock is much disintegrated, yielding fine white sand. On the line of the rail road in Sadsbury township *red oxide of titanium* occurs near the margin of the formation in some abundance. It is a mineral for which there is a small demand, being employed in the manufacture of porcelain teeth. Its value is about five dollars per pound.

Between the township of Honeybrook and West Caln, commencing near the Lancaster turnpike, above Wemer's mill, and extending westward nearly as far as the county line, there is a steep hill consisting of this formation. On the road from Downingstown to the Red Lion, in the lower part Uwchland township, the same rock occurs, in a small isolated hill running north-east and south-west for about a mile. We have already mentioned the occurrence of a similar detached hill of this sandstone near Londongrove. Another called the Buckingham mountain near Centreville, will be noticed in the chapter on the middle secondary red sandstone formation.

In my report of last year, the limits of the other belts of this formation, lying between the Delaware and the Susquehanna, including those of the South mountain, were traced with sufficient exactness. The limited scope of an annual report compels me to postpone the description of the local geology, not only of this formation but of the other secondary rocks of all that part of our first or southern district lying east of the Susquehanna.

Our explorations during the past year, were extended over nearly the whole of Bucks and Montgomery counties, but the necessity of collecting some further details, and the want of space, induce me to leave to another time, the description of the Great Red Sandstone formation, with its minerals, which constitute so large a portion of those counties, and which, will be best discussed, when time allows me to introduce the details of the entire belt in its range through Bucks,

Montgomery, Chester, Berks, Lancaster, Lebanon, Dauphin, York and Adams, in all of which counties, it has been now explored.

In detailing a portion of the observations made during the last season in York and Adams counties, I propose therefore, to omit the Red Sandstone belt, and confine myself to the Lower secondary rocks lying south-east and north-west of this range.

Of the Slate and Sandstone of Formation I. of the Pigeon Hills.

About eight miles south-westward from York, commences the range called the Pigeon Hills, rising through the limestone of the York Valley. These hills have an elliptical form, are between seven and eight miles long and three broad, terminating south-westward near the turnpike, at a point four miles north of Hanover. The strata of these hills, comprising different portions of F. I. consist usually of a dark slate and a light colored sandstone, of different degrees of fineness and compactness. The whole belt, though carefully explored, develops little of interest in an economical point of view. About four miles N. N. E. from Hanover, occur *green chlorite*, and a beautiful variety of *foliated oxide of iron*. The slate in the neighborhood shows small traces of *copper ore*. A belief exists throughout this neighborhood, that the slates of these hills are of the coal formation, and that coal perhaps exists in them; whereas they belong to the very lowest secondary formation of our State, while the workable coal is exclusively confined to a wholly different group of rocks, lying much higher in the order of stratification, and occupying an entirely different geographical range.

Of the Limestone F. II. of York Valley.

Resuming our observations along the Susquehanna, we find the southern margin of the limestone designated as F. II. near the south side of Creitz creek, below Wrightsville, where it is quarried for building stone, for the locks, &c. of the canal. The dip is towards the S. S. E. at an angle of seventy degrees. Another large quarry occurs on the north side of the same creek; while a third, in which we find some beds of variegated limestone, is wrought a little north of the bridge. The northernmost exposure of the rock near the river, is in a quarry a quarter of a mile above the bridge. The limestone here is nearly white, and has the aspect and structure of a marble, but is much traversed by cross joints, and is hence difficult to procure in large blocks. From this vicinity towards York, we notice several varieties of the limestone, some belts of which are highly magnesian, and therefore well adapted for the manufacture of *hydraulic cement*. It is a matter of just surprise that we have hitherto had no manufacture of this valuable article any where in the southern limestone belts of this state, where the material is so abundant, and where outlets to market, procured at so vast an expense to the Commonwealth, are numerous and convenient. Many chemical analysis already

made, and others now in progress in the laboratory of the Survey, establish the fact, that *nearly all* the limestone belts in the south-eastern district of the State, including also those of the Kittatinny Valley, contain bands of magnesian limestone capable of furnishing a hydraulic cement identical in properties with that so extensively manufactured in New York, and on the Potomac, near Sheperdstown.

The town of York is scarcely a mile from the southern border of the limestone; and the excavation for the rail road, a little south of the town, shows a slaty character, denoting its passage into the slate on the south. North of the Codorus, it is extensively quarried and converted into lime. Stet generally light grey or whitish. One mile north-west of the town, are extensive quarries, in one of which occurs a beautiful flesh colored marble, but not in beds thick enough to be profitably wrought. On a hill half a mile west of the town, a variegated, silicious and calcareous rock is quarried for a building stone.

That part of the limestone belt south of the Pigeon Hills ranges between their eastern end and the slate ridge to the south, and passing by Spring Forge, advances towards Hanover. South-west of the forge, the belt becomes quite narrow and interrupted by belts of slate; but it may be traced continuously between the slate ridge, or "Barren Hills," on the south, and Pigeon Hills on the north.

A belt of *iron ore* is traceable along the southern edge of this limestone, near the slate, for several miles. It passes a little south of Hanover and thence towards Littlestown. This ore was mined many years ago, but has long lain neglected, owing to the inferior quality of the iron which it produced, in consequence chiefly, of its containing a considerable portion of the *oxide of manganese*. It occurs in considerable quantity in a small hill two miles south-west of Hanover; from which point to Littlestown, detached lumps of it are visible in the soil for nearly the whole distance.

The red sandstone passing from the west end of the Pigeon Hills, encroaches upon the limestone as it advances south, until near Arnold's mill, at the State line, it overlaps the whole of the formation.

Along the southern base of the Pigeon Hills, in the slates north of the margin of the narrow zone of limestone already traced, we find another belt of *iron ore*, of less length than that on the south side of the limestone. At Moul's five miles north-east from Hanover, the ore was dug about forty years ago. Much of it is scattered about the fields. Huge rocky concretions of ore protrude themselves at the base of a spur of the Pigeon Hills, about three-fourths of a mile to the north-east. The thickness of this deposit of ore is very great, not less perhaps than one hundred feet; but the mineral is extremely siliceous, and unless a new method of working it were devised, would not justify attempts at smelting it. It is possible, however, that by the use of anthracite coal, aided by the hot blast, not only this, but many other siliceous and impure ores, if rich enough in iron, will be found ultimately capable of yielding a tolerably good metal, while with the inadequate heat from charcoal they prove quite refractory.

The northern border of this division of the limestone, after ranging along the southern side of the Pigeon Hills, folds round their southwestern termination, and meets the overlying red sandstone on their northern declivity. Extensive limestone quarries, producing a valuable lime, occur on the farm of Mr. Adam Myers, near the end of the hills. A limestone quarry exists on a farm belonging to Mr. James M'Sherry, near Conewago Chapel. Some of the beds yield a fine, compact, light colored variety, promising to be susceptible of a good polish as a marble. It affords a good lime.

The northern division of the limestone is overlapped, as we have said, along the northern base of the Pigeon Hills. It appears, however, a little east of King's tavern, ten miles from York. The course of the southern margin of the overlapping red sandstone from this point is nearly north-east, passing within two and a half miles north-west of York. Between York and the spot at which the limestone disappears at the base of the hills, it is much traversed by small ranges of slate.

The anticlinal ridge, consisting of the white sandstone and overlapping slate of F. II. prolonged from Chicques ridge at the river, ranges along the northern edge from Wrightsville nearly to York, within a mile and a half of which it terminates. The limestone folds round its western end, and extends north-eastward between this ridge and another of siliceous slate, running westward from the Codorus. These uniting, the limestone ceases, in a point, north of the belt of siliceous slate just mentioned, which belongs, apparently, to the upper portion of F. I. We find another small wedge-shaped tract of the limestone crossing the river below Bainbridge, and extending westward about a mile, when it is overlapped by the red sandstone, about a mile north of New Holland. About half a mile west of the river, near its southern margin, we find lumps of *iron ore* in the soil.

Of the Sandstone and Slate of Chicques Ridge, west of the Susquehanna.

The general structure of this ridge is that of a very much compressed or folded anticlinal axis, on the northern side of which the strata lie in an *inverted* attitude, that is to say, the rocks, originally uppermost, are seen dipping apparently beneath others, generally inferior to them in the order of stratification. The consequence is that the limestone of F. II. lying north of the ridge, dips southward, to underlie the rocks of the ridge which consist of F. I. Above the bridge at Wrightsville, the most southern belt of F. I. is a slaty sandstone evidently one of the upper strata. It dips seventy degrees south. Approaching the main axis of the ridge, we meet high perpendicular cliffs consisting of the lower sandstone division of the formation. The color of the rock is whitish, sometimes of a bluish tinge. About a mile below the mouth of Codorus creek to the north of the folded axis, the sandstone is underlaid by a tolerably thick belt of striped slates, this again, by a succession of thick strata of sandstone

and slate, the latter predominating, until we reach the limestone at New Holland. These slates constitute the upper division of F. I. Their general posture is nearly perpendicular, though sometimes they dip slightly north from the axis and sometimes they are *inverted*, or dip towards it. Half a mile above the furnace on Codorus creek, the compact white sandstone dips north sixty degrees. From this to Brillinger's, we see no more of the sandstone, the rock being the upper siliceous slate similar to that at the mouth of the Codorus. The belt of white sandstone terminates westward at a point at about two miles north-east of York, where the Codorus flows round it. The belt of siliceous slate, lying further north, passes westward from the mouth of the Codorus and New Holland, ranging south of Liverpool, until it is covered by the red sandstone at Shultz's, four miles north of York.

Of the Limestone F. II. near the southern base of the South Mountain.

The most north-easterly point at which we observe the limestone, immediately south of the South Mountain, is about a mile and a half north of Petersburg, where a beautiful white and compact variety is opened in a quarry belonging to Mr. James McCosh. About half a mile south of this, on the opposite side of a trap ridge, which intersects the formation, occur quarries belonging to Mr. Picking. The rock is here of a light grey color and remarkably soft, being further removed from the modifying influence of the once heated trap rock. Another extensive quarry occurs in the same neighborhood, two miles north west from Petersburg. Much search has been unavailingly made for limestone among the hills near the base of the mountain, ten or twelve miles westward of Petersburg, from whence the lime at present procured is all brought.

The next point at which we notice the limestone, is about two miles north of Fairfield, at Mr. James Blythe's. The rock here is of several shades of color, purplish, greenish and some of it nearly white and crystalline. On the west side of Middle creek, below Myer's mill, it again shows itself but is not quarried. The paucity of the exposures of limestone through this belt of country is due, unquestionably, to the extensive manner in which the lower secondary rocks are overspread by the Middle Secondary red shales and sandstones, overlapping every thing beneath them as far as the base of the hill.

The Rocks of the South Mountain.

The irregular chain of hills termed the South Mountain bounding the Kittatinny or Cumberland valley on the south-east, and crossing the Susquehanna, in their progress to the south-west, consist of a broad belt of nearly parallel ridges, the general direction of whose axes is not exactly coincident with the prevailing course of the mountain, the

latter being nearly from north-east to south-west, while the direction of each individual ridge or axis is more nearly E. N. E. and W.S.W. In consequence of this, the several belts of rock, range somewhat obliquely across the general course of the mountain. Thus, the coarse talcose sandstone of "Green Ridge," from ranging rather on the north-western side of the mountain belt on the State line, constitutes the middle ridge in the neighbourhood of Cold Spring, while a few miles further east it appears on the southern side of the chain.

A section across the rocks on the south of Green Ridge in Adams county, embracing the exposures on the Gettysburg rail road, will serve to show the general structure and composition of these hills.

Passing a *trap dyke* at Biesecker's, west of Gettysburg, the first excavation where the rock of the mountain is exposed shows a compact, grey, siliceous, stratum much traversed by cross joints. Below this occur a few feet of talc slate, under laid by chlorite slate. East of Middle creek is a hard grey siliceous rock and near it a chlorite rock containing specks of *epidote*. A little *iron ore* was found loose in the soil here. We next pass alternations of the grey siliceous rock and greenish slate and afterwards a deep excavation in a hard grey siliceous stratum, containing specks of *white felspar*. This includes a bed of beautiful veined grey rock. Passing the viaduct, one hundred feet of grey slate is seen graduating into sandstone. About half a mile from the end of Jack's mountain, a hill nearly seven hundred feet high, the bluish slate is interstratified with sandstone. Further to the south-west, the sandstone becomes less talcose and more siliceous. Without any material variation, this extends to the contemplated tunnel near the western end of Jack's mountain, embracing probably a thickness of one thousand feet of this limestone. Near another projected tunnel in a ridge uniting with the north-west side of the mountain there is a hard epidotic and quartzose rock of considerable thickness and near it a greenish slate. On the southern side of the next ridge, is a thick belt of a similar green slate, including bands of grey slate spotted with *epidote*. About a mile and a half south-east of the intended summit of the road, is a cutting in dark grey slate, then occur greenish slate and a purplish grey siliceous rock, spotted with some crystallized epidote. Further on we find an epidote rock containing asbestos from which to the end of the cutting occurs a dark grey siliceous rock. Near the summit a flat swamp occupies a considerable area on the top of the mountain. Near Red run, a branch of Antietam creek, a compact siliceous sandstone shows itself, similar to that along the south side of Jack's mountain. This terminates the excavation on the rail road.

On the road from Fairfield to the Emmetsburg and Waynesburg turnpike near Miney run, diggings to some extent were undertaken, several years since in search of *copper ore*. Nothing is visible in the materials dug out, calculated to inspire a hope of finding a productive copper vein in this locality. In a small ridge north of Jack's mountain, several openings from copper ore were commenced by Mr. Thomson, and a small quantity of ore obtained and a furnace built for

smelting it. These works are now abandoned. The metal occurs in the form of green and blue carbonate with a little native copper. The ore seems not to have been abundant.

The rock immediately north-west of Green Ridge between the State line and the Gettysburg and Chambersburg turnpike is a sandstone evidently F. I. no other rock appearing between Hughes's rolling mill on Cold Spring creek and Montalto furnace, on the south-west branch of Antietam. Further towards the north-east this sandstone constitutes only the south-west part of the mountain. At Caledonia furnace, on the Chambersburg turnpike, it is confined to the two narrow ridges lying west of the furnace, while the whole of the rocks south-east of this, as far as Green Ridge consist of the red and grey siliceous strata with their included greenish slates.

Crossing the mountain between Caledonia Furnace and Cold Spring, a distance of seven miles, in a S. S. E. direction, no vestige of the white arenaceous sandstone of F. I. was seen, until the foot of Green Ridge, at Cold Spring, was reached. The section displays rocks precisely similar to those on the east side of the mountain, on the rail road at Maria Furnace and at Holms's creek, showing every where marks of alteration by igneous action. In the ridge west of Caledonia Furnace, occurs a talcose sandstone; and a fourth of a mile south of the furnace, a highly altered, jaspery slate. Half a mile south of the furnace, we meet a grey, spotted, siliceous rock, evidently an altered sandstone; two miles south of the furnace, a grey, altered, siliceous rock, with dark blotches; and two miles north of Cold Spring, a greenish slate, spotted with epidote, and charged with much white quartz. One mile north of the same place, a reddish slate, speckled white, occurs; and half a mile nearer Cold Spring, is a red, jaspery, altered rock; all belonging, probably, to the thick system of slates composing the upper member of F. I., but greatly modified in texture by the intrusion of quartz and other igneous matter. Throughout this section, the strata dip invariably to the south-east. Though no anticlinal axis is visible, there is convincing evidence that the rocks have been upheaved along such an axis, and folded together, so as to make those on the north-west dip in an *inverted* altitude to the south-east—a feature very common throughout the whole range.

The mountain gap of the Gettysburg and Chambersburg turnpike divides the altered slaty rocks on the south from the unaltered sandstone on the north, until in our progress eastward we reach Newman's near the summit, east of which the altered rocks cross the road, to range north-eastward along the southern ridges of the mountain. The sandstone ridges which constitute the north-western spurs of the mountain, near Caledonia Furnace, jutting towards Green village and Shippensburg, ranging north-eastward, become the main body of the mountain, the *altered* rocks lying on the southern side. The same bed of altered rocks which lies between Caledonia Furnace and Cold Spring, and which crosses the turnpike south-east of Newman's, is

seen on the southern side of the mountain, crossing one of the head waters of Conewago creek.

Crossing the mountain by another section further to the north-east, we find the following order of things. Beginning at Cumberland Furnace, and passing to the head waters of Opossum creek, the north-western ridges of the mountain, near Cumberland Furnace, consist entirely of the sandstone of F. I. In the ridge north of Pine Grove, the rock is a more talcose sandstone, belonging probably to a higher part of the formation. Large veins of white quartz are here abundant. A whitish talcose slate rests conformably upon the talcose sandstone, dipping with it to the south-east. This latter rock forms an admirable material for the in-walls of a furnace, and is used in that at Pine Grove. Immediately south of Mountain creek, near the furnace, occurs a thin interposed belt of limestone, used as a flux, and also taken across the mountain, into Adams county, for lime for the fields. This rock contains disseminated crystals of *fluat* of lime.

Associated with this limestone, is a valuable deposit of *iron ore*, which has supplied the furnace here for a long time. It is of the kind usually found in our limestone soils, being technically the *brown hydrated proxide*, having a variety of structures. The *analyses* given in Chapter VI. displays the composition of one variety of the ore of this mine.

The limestone is evidently one of the interpolated beds common in the upper division of F. I. Passing the low ridge containing the limestone, we encounter a bold mountain of somewhat talcose sandstone, two miles in breadth, containing probably an axis of elevation with the rocks on its northern side *inverted*. On the southern flank of this ridge occurs a belt of altered siliceous rock, including a narrow band of talcose slate; and south of this, a zone of green altered slates, charged with epidote and quartz; and overlying this again, another belt, of a more siliceous altered slate. It is interesting to observe the importance which a single belt of limestone will give to a locality. It has here given rise to a rich deposit of *iron ore*, rendering productive a most beautiful and sequestered spot in a chain of hills, elsewhere remarkable for their forbidding features and sterile soil. The calcareous rock is only developed, to any extent, near the furnace, though it is said to be visible at Dull's saw-mill three miles higher up Mountain creek.

Another section across the mountain, still more to the north-east, extends from south to north along the Baltimore and Carlisle turn-pike. The first important stratum of the hills is the usual grey siliceous altered rock so common along their southern side. North of this, about three miles from Petersburg, occurs the dark green slate, with its epidote and white intrusive quartz. Succeeding this, is an extremely compact, siliceous altered slate; and beyond this, a reddish grey rock, of the same series, containing specks of reddish felspar and small veins of epidote; and near this, the fissile talcose rock, several times mentioned before. North of these, we pass a tract of low ground,

and then a high, rough ridge of sandstone ; ascending which, we come to Mountain creek, at Holly Furnace—not now in operation. Beyond this to the north, is another bold ridge, the northernmost of the chain, consisting also of the white sandstone of the lower division of F. I., which here resembles closely the same rock as it occurs in Chicques ridge, on the Susquehanna. The beds here have a steep southern dip, of about seventy degrees. This dip is evidently, however, an *inverted* one, as these are the *lower* rocks of the formation, and lie north of the proper position for a folded or anticlinal axis. Between the northern base of this ridge and the margin of F. II., the limestone of the Cumberland Valley, a deep deposit of diluvial matter hides from our view nearly the whole of the slaty or upper division of F. I. ; which, in consequence of its easy denudation, is commonly found in the valley at the foot of the mountain, thus covered by transported matter.

The north-eastern termination of the mountain, near Dillsburg, consists entirely of the lower sandstone, the altered slaty belt on the southern side having disappeared between the Petersburg and Carlisle turnpike and the end of the mountain, in consequence of the subsiding of the axis of elevation. It ends in two principal ridges. In a rough valley between these, occurs a yellow porous sandstone, often indicative of *iron ore*, some of which was found on the surface near the end of the southern ridge. A little north of Dillsburg, the limestone of the Cumberland Valley folds round the eastern end of the mountain, and appears on Dogwood run, south of Yellow Breeches creek, where it is covered by the overlapping rocks of the middle secondary series, consisting here of the calcareous pudding-stone, or Potomac marble, and altered red shale and red sandstone.

CHAPTER II.

Sketch of the operations of the Survey in the North-eastern Appalachian district, or that, lying between the South mountain and the Allegheny mountain, and between the Delaware and Susquehanna rivers, embracing the Anthracite coal fields.

The investigations in this district during the past year consisted of numerous detailed examinations in the southern coal basin, resulting in the developement of new and clearer views respecting the position of the coal in many important tracts. Many valuable local facts were ascertained, tending to give a truer insight into the structure and re-

sources of this great coal field. By an extensive and laborious comparison of these, we have been enabled to delineate the outcrop of the principal important coal seams, upon our enlarged geological maps of the region, and to represent, as far as ascertainable, the relations of the beds beneath the surface, in an extensive series of sectional drawings. These sections, compiled from measurements as exact as could be made or procured, will furnish in conjunction with the maps when completed, a picture of the position of the coal throughout the several basins: rendering plain, many intricate features which no mere description, unaided by them, could make intelligible. The total number of sections at present drawn, displaying the situation of the coal, amounts to about one hundred and twenty. I am happy to state that the map intended to exhibit, on a large scale the topographical features of the several coal basins, and as nearly as practicable the range of the coal, is in a condition of considerable forwardness, though from the excessive complexity and truly wide extent of our anthracite region, much research will yet be necessary in order to complete it.

Having in my last annual report described with sufficient precision the approximate boundaries of the coal measures, in the numerous lesser basins into which the whole region is subdivided by a series of nearly parallel lines of elevation, and conceiving it injudicious, nay, wholly impracticable to enter at this time upon any local and partial details, which if published, could not be intelligible without the map and drawings, and which in their most compressed form would swell this report to more than twice its present bulk, I shall postpone a particular description of the district and refer the reader to my final and general report, which I confidently hope to finish in about two seasons more.

While carrying out the train of research begun during a previous season, in the several anthracite coal fields, attention was also especially directed to a subject which at present claims a high share of importance in connection with the resources of this portion of Pennsylvania. The application of anthracite coal in the process of smelting iron, first made in Wales, and recently introduced with entire success at Pottsville, by an enterprising citizen of the State, has called forth much inquiry as to the productiveness of our anthracite region in regard to ore.

I have therefore spared no pains to collect information bearing upon this important question, visiting and causing to be visited, particularly in the Pottsville region, every locality promising to be valuable in regard either to the quality or quantity of the mineral. Out of a variety of specimens collected, as great a number have been analyzed as the limited time allowed for the preparation of an annual report would permit. These have been selected with a view to show particularly the prevailing quality and average richness of the ores of the region generally. Especial care has been therefore taken to submit to chemical examination, such specimens only, as represent the average character of their respective beds, choosing those freshly

opened in the mines or in some deep excavation, and rejecting as far as possible, samples gathered from the outcrop or found loose on the surface, as these invariably contain *two high* a percentage of iron, to prove a fair criterion. The results of the chemical examination of these ores will be found detailed in chapter VI. of the present report. While making these explorations, information on the subject was freely imparted to the proprietors of the lands, or mines, respecting their own deposits and a number of chemical analysis of their ores were presented to the owners with a view to guide them in their search.

The same views of utility which induced us to direct a share of our attention to the geological and chemical relations of the iron ore in the anthracite coal region have led us to explore both recently, and in previous seasons the district in search of limestone, valuable in many of the arts, but indispensable in that of making iron. Careful analysis have therefore been made of all the more promising calcareous bands appertaining either to the coal measures themselves, or to the lower formations situated outside of their boundaries. We have yet found no calcareous bed within the coal fields with a sufficient proportion of carbonate of lime to justify its use as a flux for iron. The mottled calcareous layers which occasionally occur in the upper beds of red shale F. XI. on the side adjacent to the conglomerate that underlies the coal, have also been subjected to chemical trial, the results of which made upon the purest of these yet found will be included in the final chapter. I have also recorded an analysis of the limestone F. VI. which ranges through the Orwigsburg valley south of the Pottsville coal basin, deeming it the nearest belt to the coal measures, pure enough to be employed as a flux. With the same view an analysis is given of the limestone F. II. of the region south of the Blue mountain, the variety examined being procured adjacent to the Schuylkill, about nine miles north of Reading, and being the kind now successfully employed in the blast furnace at Hamburg.

The amount of ore in each of the several coal basins of the anthracite region being evidently very great, and sufficiently ample should the quality be found proportionately good to contribute materially towards the supply of the numerous large blast furnaces likely to be erected in and around these coal fields at no distant day; it is not necessary in the present early state of researches on this subject to attempt a description of the localities already developed. Besides being too burdensome for an annual report not furnished with the drawings necessary to explain them, these particulars respecting the ore would be of only very transient interest, inasmuch as every month is bringing to light many new deposits and altering the aspect of those already opened. I have thought it judicious, therefore, to submit at present only the chemical part of our examinations, as detailing the species of information which is at this time of more general and immediately practical interest. It was my intention to offer more than twice the present number of analysis of ores found in the anthracite coal mea-

asures, but the accidental miscarriage of a large box of specimens collected at a number of localities, has interfered with the design.

At this period when to all appearance, anthracite is about being extensively applied to the manufacture of iron, it is important that the composition of this invaluable combustible should be adverted to, for success in using it must much depend upon attention to the peculiar properties which distinguish it from other varieties of fuel. I have therefore deemed it desirable to accompany the analysis of the ores of the region with the results of similar experiments upon the coal, placing in the same chapter for the purpose of comparison, the chemical constitution of a number of coals from other districts in the state.

After prosecuting, during the early half of the season our examinations among the coal measures, and obtaining as much local information as practicable concerning the localities of iron ore, developed in the various recent excavations or in natural exposures, a portion of our attention was given to the geology of the valley north of the Blue or Kittatinny mountain. This belt of country was minutely explored from a point some distance east of the Little Schuylkill, westward to the Swatara, and a detailed map of its topography exhibiting the true position and range of its numerous and somewhat intricately distributed formations was at the same time constructed. This map will be extended hereafter to embrace the whole belt of country lying north of the Blue mountain, from the Delaware to the Susquehanna, and be connected if our time will permit with the general map of the coal region.

CHAPTER III.

Sketch of the Geology of those parts of the Third or South-Western Appalachian District, examined during the last year, embracing the counties of Cumberland, Franklin, Mifflin and Huntingdon, a portion of Bedford, with a part of Union, and a small part of Centre.

Turning, now, to the district lying south-west of the Susquehanna, embraced between the South Mountain and the base of the Allegheny Mountain, I shall, in presenting a general sketch of the geological structure and resources of the portions last explored, commence with that portion of the Great Kittatinny Valley, which includes the counties of Cumberland and Franklin, and which in this State is commonly called the Cumberland Valley.

SECTION I.

Of the Rocks of the Cumberland Valley, embracing Formations II. and III., with their associated Iron Ores, &c.

In describing the formations of this valley, we shall commence, as usual, with the south-eastern belt, taking it up at its north-eastern end, and tracing it southwardly. This belt is the great limestone tract of the south-eastern half of Cumberland and Franklin counties, our account of which commences at the Susquehanna river.

Limestone F. II. in the South-Eastern half of Cumberland and Franklin Counties.

Resuming our section along the south-western bank of the Susquehanna, we find the southern margin of the limestone overlapped by the red shales of the *middle secondary series*, about two miles below New Cumberland, at the mouth of the Yellow Breeches creek, the limestone rising in a moderately elevated cliff, near the river. Near its contact, it has derived a reddish tinge from the overlying red shale; but a little further north, in Musser's quarry, it loses this strain, some layers presenting the aspect of a fine white marble, which, if thick enough to work, would be a valuable rock. The prevailing dip of the limestone here is towards the S. S. E., at an inclination of forty-five degrees. Near the mouth of the creek, the limestone contains a narrow belt of slate, visible occasionally for several miles up the stream, and extending, indeed, the whole way to Maryland, along the southern border of the formation. Above New Cumberland, the limestone is discernable along the water's edge, preserving its usual character and dip. About a mile above, the dip diminishes to thirty degrees south, and gradually grows less, until a little more than a mile below the rail road bridge, at Harrisburg, the strata become horizontal, indicating this as the position of a flat anticlinal axis. North of this, for about a fourth of a mile, they incline northward, at an angle not exceeding twenty degrees. We then find a flat synclinal axis, beyond which, for three-quarters of a mile, to the bridge, the steeper southern dip is resumed, gradually increasing, until at the bridge it is about fifty-five degrees. The steep southern dip continues to the boundary of the limestone and slate, or F. III., which is seen in the ravine at the bridge, along which the rail road passes. The slate here, dipping to the south or under the limestone, is evidently inverted by a folding of the rocks in the limestone belt, somewhere between this point and the synclinal axis above mentioned. The natural or original position of the great slate formation of the Kittanning valley, is *above* the limestone.

From this point of junction near the bridge, the line dividing the two formations, ranges nearly westward to the most southern bend of the Conedogwinit creek; following thence the *general* course of that stream, the southern bends of which reach but do not penetrate the

limestone, while its northern meanderings lie all in the slate. The limestone, towards its northern margin, contains thin belts of the slate, similar to that noticed as ranging near its southern side. Near Newville, the boundary leaves the course of the Conedogwinit, to bear somewhat more southwardly. It here makes a double turn, taking a zigzag course in consequence of an irregular anticlinal axis near Newville, which elevates the limestone in a long projecting point, penetrating the slate north-westwardly. Resuming its regular course, it passes south-west from Newville, leaving Shippensburg three miles to its south-east, and then deflecting still more towards the south, it passes a little west of Green village, and reaches the Conococheague north of Chambersburg. It follows this stream past the town, and after pursuing it about four miles, stretches away in a S. S. W. direction to Greencastle, and thence on to the Maryland line, which it intersects about a mile east of the Conococheague.

The southern margin of the limestone leaving the Susquehanna two miles below New Cumberland, runs first north-westward, and then westward for several miles, leaving a narrow belt of the rock on the south side of Yellow Breeches creek. The overlapping red shale crossing the creek about two miles north of Lisburn, follows its border to Bryson's, west of Lisburn, where the red shale leaves the limestone, the formation beyond this point being bounded on the south by the rocks of F. I. Making the general course of the creek its margin, the limestone passes by the south side of the stream, at Williams's mill, about three miles north of Dillsburg, and extends some distance along Dogwood run, folding round the end of the South Mountain.

Further towards the south-west, the edge of the limestone lies near the north-western base of the mountain, though it is frequently concealed by a covering of diluvium. In some places, owing to a fault or sudden folding together of the slate of F. I., immediately at the base of the mountain, the limestone approaches the sandstone, and indeed in some of the ore banks, situated low down on its declivity, limestone shows itself beneath the ore. In these instances, however, it is probably not the main body of the formation, but a narrow belt in the slates of F. I. The limestone, generally, is much interstratified with greenish and reddish slate along the base of the mountain.

Having thus defined, with sufficient accuracy, the two boundaries of this broad tract of the limestone, I shall next notice some of the details connected with the formation most deserving of description in this place, leaving the minute and systematic delineation of the whole for the pages of my final report. Proceeding westward from the Susquehanna, we meet with a deposit of good iron ore, about two and a half miles from the Harrisburg bridge, on the farm of W. R. Gorgas. The ore is imbedded in the ferruginous soil which overlies the limestone. It occurs in bunches and irregular veins, the general direction and dip of which coincide somewhat with those of the underlying limestone. It is conveyed by the rail road to the river, and thence by the canal to the furnaces above Harrisburg. It is the usual

brown ore, and is of a cellular structure. The analysis in chapter VI. will show its average composition.

A trap dyke crosses the Yellow Breeches about two miles north of Lisburn, altering, more or less, the adjacent limestone. In the vicinity of Sheperdstown, three miles south of Mechanicsburg, the limestone encloses a considerable tract of slate, rather more than half a mile in breadth. This slate is probably a portion of F. III., folded in between the limestone in a compressed synclinal axis. About a fourth of a mile north-west of Sheperdstown, iron ore, apparently of good quality, has recently been obtained. It has not thus far proved abundant, though little has been done towards developing it. At the Carlisle Iron Works, six miles S. S. E. from Carlisle, a trap dyke, issuing from the mountain, crosses the Yellow Breeches creek immediately at the furnace, and extends north twenty degrees east, entirely across the valley, meeting the base of the Kittatinny or North mountain about two miles east of Sterrett's Gap. It forms a sharp, very narrow, rocky ridge, from ten to seventy feet high—a useful natural boundary employed to designate the township lines. The limestone is considerably affected by it in its texture and color, though not much disturbed in its prevailing south-eastern dip. In a quarry near the furnace, a little removed from the trap, the rock has the aspect of fine grained, whitish, and dove colored marble. This trap dyke, and the contiguous beds of the limestone, are well seen in the cutting on the Harrisburg and Chambersburg rail road, where the dyke is about sixty feet wide. Another lesser trap dyke penetrates the limestone a little westward of the former.

The ore which supplies the Carlisle Iron Works is obtained at several points. One variety, denominated "mountain ore," occurs along the northern slope or base of the first sandstone ridges, near the junction of the limestone. Another variety, known as limestone or *pipe ore*, belongs to the ferruginous soils overlying the limestone itself. The iron obtained from the mountain ore is generally "cold, short," hard and brittle; while that derived from the limestone ore is softer, tougher, and more tenacious. The mountain ore is in some furnaces employed alone for the manufacture of foundry pigs and castings, but a mixture of the two kinds is generally deemed necessary for the production of good cast iron for forging. One principal reason of this is, that in the mountain ore derived originally from the strata of F. I., the oxide of iron is associated with a larger proportion of the oxide of manganese, and other deleterious constituents, than generally accompany it in the ores of F. II., originating from a different source. Both of these varieties belong to the general species called by mineralogists, brown hydrated iron ore, though they assume a considerable diversity of aspect and structure, arising from their greater or less degrees of richness and purity, and the manner of their concretion.

The mountain ore, obtained a mile and a half south-west of the Carlisle works, is of several descriptions. In the upper portion of the deposite, much of it is compact, passing under the name of "hard

ore." The "honey-comb ore," lying beneath this, or imbedded between it, is a softer and more porous variety, more readily reduced in the furnace. Half a mile south from the furnace, a small body of a somewhat different ore has been met with.

The "limestone ore" employed at this furnace, is obtained from a belt about two miles N. N. W. from the works, where ore has been dug, in different places, for several years. The present supply is chiefly from a deposit about eight feet thick, reached by a shaft from sixteen to twenty-five feet deep. Much of it belongs to the fine variety denominated "pipe ore," consisting of a congeries of parallel stalactitic tubes or stems, from whence it derives its name. One part of this ore is mixed with two parts of mountain ore in the manufacture of forge pigs. For the chemical composition of these several ores, see chapter VI.

The limestone employed as a flux at this furnace is selected with a view to facility in procuring it, more than from a regard to its purity; some of the belts lying further north would be better adapted. Between the deposits of limestone ore above mentioned and Carlisle, ore is found in several places; an extensive digging, now abandoned, occurring near the Hanover road. Half a mile south of this, on a farm belonging to Mr. Holmes, a very good looking ore occurs, which has been more recently mined. Between this and Carlisle, other excavations exist, from whence the ore is conveyed across the North mountain to a furnace south of Landisburg, where it is mixed with ores of that neighbourhood.

In the neighbourhood of Carlisle, occurs much good limestone; both the ordinary kind, adapted for making lime, and the magnesian variety, suitable for the manufacture of *hydraulic cement*.

About four miles westward from Carlisle, near the State road occurs a neglected excavation where iron ore to some extent has been procured. About four and a half miles south of the town near the turnpike, is a deposit of apparently good ore formerly wrought to some extent, to supply Holly furnace not now in operation. On the Walnut Bottom road about five miles south-west from Carlisle ore, is abundant on the surface of a little hill. Southward of this at Peffer's, between the foot of the mountain and the creek, ore was formerly obtained for Holly furnace, and more recently for Cumberland furnace. See Analysis, chapter VI. Though not far from the sandstone of the mountain, some of it is of the variety called pipe ore, characteristic of the limestone formation, parts of it however, are magnesian. Along the low ground, near the foot of the mountain, ore is abundant on the surface for a considerable distance westward.

Cumberland furnace, the property of General Thomas C. Miller, not in blast at the time of our explorations in the vicinity, has been smelting chiefly the ore obtained near the base of the sandstone ridge of the mountain about three miles south-west from the furnace. This ore appears to lie in bands, and large bunches or nests in the loose soil near the bottom of the declivity of the mountain. The mine

chiefly wrought at present, is an irregular excavation, from thirty to forty feet deep, in the sides of which, the ore is scattered in lumps throughout a large extent of the deposit, but is best, and most abundant nearest the bottom. The ore from this bank is mixed with an ore from the limestone tract obtained a mile and a half north of the furnace. For an analysis of each of these ores see chapter VI.

Iron ore occurs on the surface about seven miles west of Carlisle on the farm of Mr. William Kerr, in considerable quantity. For the composition of this ore see chapter VI.

Near the Big Pond at the head of Yellow Breeches creek, we come upon Pond Furnace, owned by Mr. John Moore, worked by the hot blast and making foundry iron. The ore smelted at this furnace, is procured from F. I. on a low spur of the mountain, south-west of the Pond. The old excavation on the eastern side of the hill have lately been left and another deposit opened on the western side by a shaft which shows several feet of ore about twenty feet from the surface. The limestone employed as a flux in Pond furnace, is collected from the surface fragments of the neighbourhood and is therefore of every diversity of character. For an analysis of the ore see chapter VI.

Mary Ann furnace, the property of Messrs. Whitehill and Ellis, lies about three miles west of the Pond. Near it is Augusta furnace, belonging to the same firm. The latter is not in operation. These furnaces are situated close at the foot of the mountain, about three miles south-east of Shippensburg. Mary Ann furnace, now in blast is supplied with ore from two banks, one lately opened, called the "Helm bank," three miles north-east of the furnace, and another called the "Clippinger bank," two miles towards the north-west. The Helm bank ore overlies that part of the limestone which is much interstratified with slate, being near its margin. The ore is apparently about two feet thick, dipping steeply to the north-east, but varying much in quantity in different parts of the excavation. The Clippinger bank yields an ore of the very best description, much of it being stalactitic, or of the kind called pipe ore. The analysis to be found in chapter VI. will display the prevailing composition of the ores of both these banks.

The above Clippinger ore occurs in irregular nests in the interstices of the limestone rock, surrounded by a very tenacious reddish clay. The quantity fluctuates much in different spots and the water incommodes more or less the deep diggings. These circumstances attend nearly all the deposits of the limestone ore in the valley. Where the ore occupies the interstices between the beds of limestone, it is almost invariably pure and of the pipe ore kind, though the quantity in these situations is apt to be precarious. The mountain ore obtained near the junction of the limestone and the sandstone of the mountain and therefore, generally along the slaty or upper division of F. I. is procured with greater certainty, but is frequently quite unfit for making forge pigs without an admixture of the purer ore of the limestone, being used by itself only for foundry iron. The flux used in

Mary Ann furnace is a limestone procured in the vicinity of the Clipping bank.

Southampton furnace is situated about three miles further to the south-west, or four miles south of Shippensburg. It belongs to Mr. Charles Wharton, of Philadelphia. The two furnaces in blast here are supplied with ore from these different banks. One called the "Hill bank," lying about three hundred yards west of the upper furnace, contains the mountain ore in its usual varieties. That in the upper part of the mine is hard and cold short while a honey-comb ore lying beneath it is of much better quality. The ore of this bank supplies the upper furnace which uses the hot blast and makes foundry iron and castings.

The lower furnace is furnished with ore from a mine at Kressler's, three-fourths of a mile to the north-west, and also from the "Rail Road bank," lying in the limestone formation, four miles west of the furnace. The ore at Kressler's has been extensively wrought for some years. It occurs in nests and irregular layers in the soil and rotten slate, which have a range and dip nearly coinciding with the direction of the underlying strata. This ore is esteemed well adapted for making good bar iron, but is less productive in quantity than some others in the neighbourhood. Much loose ore is visible on the surface north of the present excavation. The "Rail Road bank" formerly yielded a valuable supply of good ore, but the encroachment of the water and probably a reduction in the quantity of ore, have caused it of late to be less vigorously wrought. The ore exists rather in bunches or nests than in regular layers and is hence very variable as to quantity. A small ridge of limestone bounds the ore immediately on the north. The lower furnace, smelting these ores, makes forge pigs for bar iron, and uses the blast cold. For the *analyses* of these several ores consult chapter VI.

Proceeding northward to the neighbourhood of Shippensburg, a moderate amount of excellent ore has been procured in a spot called the "Pilgrim bank," near the northern margin of the limestone, three miles and a half from the town. A good ore was formerly obtained on the farm of Mr. Hamills, a mile and a half south-east from the town. Ore was also procured about a mile and a half west of Shippensburg, at the old Roxburg bank. It was the *stalactitic* or *pipe ore* and made a bar iron which was much esteemed for its soft and tough qualities, but as usual with ore of this description the quantity was limited. For *analyses* see chapter VI.

About two miles south-east from Greenvillage, and half a mile north of the rail road, a deposit of beautiful *pipe ore* of excellent quality, is wrought for the supply of Caledonia furnace, to which it is conveyed a distance of eight miles in wagons. It produces a good iron and with great facility, agreeing in these respects with the pipe ore generally. It occurs in bunches, which together form an irregular layer conforming with the direction of the adjacent limestone. Its position is between two little ridges of the limestone, one of which immediately bounds it on the north. It is deeply covered with earth

and must be somewhat expensive to procure. For *analyses* see chapter VI.

Caledonia furnace, the property of Messrs. Stevens and Paxton, is situated on the Gettysburg and Chambersburg turnpike, ten miles from the latter place. It is supplied with ore from several deposits, besides the Greenvillage bank already noticed. A belt of ore ground extends apparently for several miles near the line of contact of the limestone of the valley and the sandstone of the ridges, which jut forward in advance of the main body of the mountain. On this line of ore, coinciding probably with the position of the crushed slates which intervene between the limestone and the sandstone, the Pond banks occur about three miles from Caledonia works. They consist of extensive diggings in which the ore is met with at various depths in nests and irregular layers included in a ferruginous soil, much of it has a hollow reniform structure. About three hundred yards south of this, a bed of ore was formerly wrought for the supply of Montalto furnace. It overlies the sandstone, and yields a metal of very indifferent quality. The flux employed in Caledonia furnace is procured a little north of the Pond diggings.

Another excavation furnishing ore for the same furnace occurs three miles further to the south-west, at Hiefner's. This bank situated further from the mountain than the former, yields an open and crumbly ore which smelts with facility but produces a somewhat cold short iron. The chemical composition of these ores will be found among the analysis in chapter VI.

In one of the openings at Hiefner's, an impure limestone was encountered thirty feet from the surface. A little eastward of the openings, some pipe ore occurs in the soil, for an analysis of which see chapter VI.

Another belt of ore ground seems to exist on the summit of a little ridge of limestone north of the former excavations. This ore is different in quality from the other and promises to be abundant twenty feet below the surface. The ridge extending southwestward, the ore seems to continue along it, and about three fourths of a mile from the Hiefner bank, occupies the surface in an abundance seldom seen. It has been partially opened here, but making a highly cold short iron has been abandoned. These deposits of ore seem to range nearly along the line of contact of the limestone, and a narrow interposed belt of siliceous slate and sandstone.

About a fourth of a mile south-east of Beattie's on the turnpike, occurs a dark colored limestone, an unsuccessful trial of which as a flux was made in the furnace. The *analyses* showing its composition will be seen in chapter VI.

Iron ore, of very inferior quality, occurs between two ridges of sandstone three miles N. N. E. of Caledonia Furnace; affording another evidence of the impure nature of the ores derived from the rocks of the South mountain, when compared with those which occur in the limestone of the belt immediately north-west of it.

Montalto Furnace, the property of Mr. Hughes, is situated on a branch of the Antietam creek, about seven miles north-east from Waynesburg, and near the foot of the outer sandstone ridge of the mountain. Though ore appears upon the surface, in more or less abundance, the whole way along the north-west base of the mountain from Ege's Carlisle works to this place, yet no where does it occur in such profusion as between the Caledonia diggings at the pond and a point two or three miles south-west of Montalto. This furnace is supplied from extensive excavations lying about a fourth of a mile north-east of it, on the declivity of the first sandstone ridge. The ore occurs, as in other similarly situated mines, in the loose soil of the mountain side, in nests and irregular layers, varying greatly in their dimensions; but the whole deposit seems to be of prodigious magnitude. It is believed by the miners, that the body of ore in which they are now working is not less than forty feet thick and sixty or seventy yards wide,—including, of course, the ferruginous earth between the bunches and veins of ore. The lower portion of the ore is the purest. This ore, so abundant in quantity, does not, however, yield a high percentage of iron. The furnace, seems to be a successful one, producing annually about eight hundred tons of metal, in the shape of castings and forge pigs for the use of two forges and a rolling mill, situated on the east branch of Antietam creek, five miles below the Cold Spring. The composition of these two ores is recorded in chapter VI.

In one of the deeper diggings of Montalto, a band of limestone has been reached, being a layer probably in the slates of F. I. It is interesting to observe the connection between limestone rocks and large deposits of iron ore of the variety, called *brown hydrated per-oxide*.

South-westward from Montalto, much ore strews the surface along the north-western side of the mountain. In the neighbourhood of Tomstown, it occurs in large blocks, but is very silicious, being associated with fragments of the yellow silicious rock already alluded to as frequently accompanying the iron ore along the mountain.

The limestone folding round the southern end of this mountain ridge, extends some distance up the little valley of the Cold Spring branch, appearing on the north side of Green Ridge below the rolling mill. *Iron ore*, in moderate quantity, but of inferior quality, has been dug to some extent on the north-west side of the stream. The *analyses* exhibiting its chemical nature may be seen in chapter VI.

A considerable amount of ore is visible in the soil on the farm of Mr. Middaer, three miles north-east from Waynesburg. It promises to be rather too silicious to make a superior iron. For *analyses* see chapter VI.

On the southern part of the same farm, and also on another adjoining one, loose masses of tolerably pure white sulphate of baryta occur. It probably occupies a position between narrow belts of limestone and slaty sandstone, which traverse the hills of this neighbourhood.

Proceeding from the foot of the mountain towards Waynesburg, after leaving the low grounds, we first meet with slaty limestone, alternating for some distance with slate, until we reach the second ridge, three miles south-east from Waynesburg, where a band of white limestone crosses our section. This latter rock is quarried, and shaped into tombstones, about three miles further south west. On the top of the ridge, the limestone is of a dark color, alternating over a breadth of a mile with bands of slate. In the next ridge, two miles south-east of Waynesburg, the limestone is interstratified with a thinly laminated green slate. Near Waynesburg, the slate becomes more silicious, some of it being reddish, and nearly all of it containing minute scales of mica.

The line of iron ore seems not to extend south-westward much beyond Midduer's; for in crossing its range in several places between Waynesburg and the foot of the mountain, few indications of ore were visible on the surface.

On the southern branch of Antietam creek, near the Maryland line, we again encounter the band of white limestone at Royer's. The bed is several feet thick, but somewhat divided by thin sheets of a greenish slate. It is a beautiful rock, of a white aspect and fine texture, and where large blocks are not required, might be advantageously employed as *marble*.

A rather extensive cavern occurs in the limestone at the north-eastern end of the ridge, a little lower down the same branch of Antietam creek. Lower down the stream, at David Funk's, occurs a grey calcareous and silicious rock, in thin layers, from which excellent flag stones are quarried. Still further down, and near the State line, is a belt of limestone, said to yield a lime which will not slake after being burned.

Near the west branch of Antietam creek, one mile north-west of Waynesburg, is a deposit, of considerable superficial extent, of *travertin* or *calcareous tufa*. A similar deposit is visible near the mill east of Chambersburg, and in several other places along the streams of the limestone region, where the water is highly charged with carbonate of lime. This material, when in a sufficient pulverulent condition, is an admirable manure, particularly when applied in compost.

The north-west border of the great limestone belt passes through the borough of Chambersburg, in the neighbourhood of which some bands of the rock are *fo-siliferous*,—a character which the formation rarely assumes any where in the Kittatinny valley north-eastward of Franklin county.

About seven miles southward of Chambersburg, in a ridge called "Grindstone Hill," we find a bed of sandstone, interstratified with the limestone, yielding a material suitable for rough grindstones.

Advancing from Waynesburg towards Greencastle, we cross alternating belts of limestone and interstratified greenish slates; and beyond these, the limestone, is nearly uniform over a considerable breadth of surface, diversified as usual, however, in color, composi-

tion, and properties. Four miles north-west of Waynesburg, occurs a dark bituminous variety; and in a ridge two miles further, a band nearly white. Immediately north-west of Greencastle, we encounter the line of contact of this wide belt of F. II. and the slates of the base of F. III. This latter rock, to which we shall next proceed, ranges along the north-western margin of the above zone of limestone the whole distance across the State from the Delaware river to this point, and southward into Virginia.

Of the Great Slate Belt F. III. of the Cumberland or Kittatinny Valley.

The uniform character and composition of this wide formation, together with its general deficiency in interesting and useful minerals, will render a detailed description of it unnecessary in the present place. Its south-eastern margin has been indicated in defining the north-western boundary of the limestone. From the Delaware Water Gap to Strasburg, in Franklin county, its north-western limit coincides with the base or flank of the Kittatinny or North mountain, where it supports the massive sandstones of F. IV. occupying the summit of the ridge. From Strasburg to the Maryland line, the slate recedes from the mountain, and is bounded on the west by a wedge-shaped tongue of limestone, the limit between the two rocks passing the villages of Strasburg and St. Thomas or Campbellstown, and intersecting the Maryland line about a mile west of Coneocheague creek.

About a mile and a quarter from the base of the mountain, at the Susquehanna river, the slate includes a thin belt of limestone, imperfectly visible at the river's side. Either the same or another bed is seen about a fourth of a mile nearer the mountain. This belt seems to extend westward several miles,—growing, however, gradually thinner and more slaty, and ceasing, probably, south-east of Sterret's Gap.

In no part of the slate formation have we found the strata possessing the structure and cleavage requisite to produce *roofing slate*. The nearest approximation to that useful variety which we have yet seen, occurs in the bed of the Conedogwinet, above Alter's mill, where the rock is traversed by cleavage plains of tolerable regularity, but is destroyed from usefulness by containing *sulphuret of iron*.

At "Dublin Gap," north of Newville, there occurs a spring highly charged with sulphuretted hydrogen; an analysis of which, together with that of other mineral waters, will be given in a future publication.

Some bands of the slate, particularly those lying adjacent to the limestone, are highly carbonaceous and of a dark color, resembling somewhat the slates of the coal measures. This analogy in their appearance, notwithstanding the conclusiveness of all geological evidence to the contrary, induces many persons, not familiar with our stratification, to suppose that the formation may actually embrace

coal. Excavations have from time to time been made, therefore, at various places in the valley for the last fifty years, in the confident belief that coal would be discovered, and though in every instance unsuccessful, we find them still occasionally renewed.

Of the Belts of Slate and Limestone in the South-Western part of Franklin County.

The south-western portion of Franklin county contains three moderately broad belts of limestone, alternating with three belts of slate, occupying the interval from the margin of the great slate formation above described to the eastern slope of the Cove mountain. An anticlinal axis ranges nearly centrally along each zone of limestone, imparting to the intervening belts of overlying slate a regular synclinal structure. The most eastern, and by far the largest, range of limestone, is that already alluded to as terminating in a long tongue near Strasburg. It is broadest at the Maryland line, and does not materially diminish in width until we trace it about three miles north of the Greencastle and Mercersburg road, where it is about three miles wide. West of St. Thomas, it is but little more than a mile from its eastern to its western border, which is within three-fourths of a mile of Parnell's knob. Here it curves a little eastward, taking a direction about N. N. E. to Strasburg, following the foot of the mountain until it disappears in a narrow point under the overlying slate. The anticlinal axis which runs somewhat centrally along this belt, prolonged beyond Roxbury, seems to extend for many miles towards the north-east, being probably the same axis which separates the North mountain, at Dublin Gap, from the spur lying south of it, and which is thence prolonged through Perry county.

The usual aspect of this limestone is rather uniform. The beds belong to the upper half of F. II.; some of those in the southern part of the tract, near the anticlinal axis, being magnesian, and well adapted, therefore, for furnishing *hydraulic cement*. About five miles north-east of Mercersburg, and two and a half miles from St. Thomas, not far from the anticlinal axis, lies a deposit of iron ore, no longer wrought. It is stated to have yielded a good, soft iron; it was, however short or brittle at a welding heat. When roasted or smelted, it gave off a strong odour of *garlic*,—a circumstance indicative of its containing arsenic. The presence of arsenic in this ore I have ascertained by analysis, the results of which, showing its chemical composition may be seen in chapter VI.

The belt of slate which bounds this tract of limestone on the west, embracing both sides of Claylick mountain, at the Maryland line, ranges a little east of north to the foot of Parnell's knob, where it again separates by receiving the mountain in its synclinal axis, one portion passing along the eastern and the other along the western base and slope. The overlying sandstone beds of F. IV., occupying the tops of Claylick and Parnell's mountains, in the middle of the trough of slate have a nearly perpendicular dip, implying that they

have actually been folded together, along the sinclinal axis, by an action like that of closing a book with its back or cover downwards. West of this belt of slate, the average width of which somewhat exceeds a mile, there ranges a narrower zone of limestone, belonging to F. II., traversed longitudinally by an anticlinal axis, which has lifted the limestone to the surface, and given to the rocks east and west of it the steep inclinations which they possess. This anticlinal belt of limestone, passing out of Blair's valley, between the Claylick and Two Top mountains, at the Maryland line, ranges to the mouth of Bear valley, separating Parnell's from Jordan's knob. Its average breadth is about half a mile. The rock exhibits the usual variety in its several beds, some of which are siliceous, while others again are adapted to produce an excellent pure lime by burning. Certain bands of it are evidently of the kind suitable for hydraulic cement. About a mile and three-quarters from Parnell's knob, the soil above this limestone contains a deposit of iron ore, smelted in the small furnace at Loudon,—which was not, however, in operation during the past summer.

West of the last described belt of limestone, ranges another parallel zone of the slate, also about half a mile in width, which, like the former mentioned tract of slate, contains a synclinal trough, in the middle of which lies the Two Top mountain on the south and Jordan's knob on the north.

To the west of this slate ranges another anticlinal belt of limestone, emerging from between the Two Top and Little Cove mountains south of the Maryland line, and ranging along the foot of the latter to Loudon, and thence for several miles along the middle of Path valley, vanishing in a narrow point north-west of Fannetsburg. The elevation of this belt of limestone has caused the eastern inclination of the rocks in the Two Top and Jordan's mountains, and the western dips in the Little Cove and Tuscarora ridges. We thus perceive that all the vallies subordinate to these axes of elevation contain the limestone or its next superior rock, the slate, having in every case anticlinal dips; while the mountain ridges included between these vallies, consisting of the higher stratum F. IV., rest invariably in the synclinal troughs embraced between the lines of elevation.

On the west side of the last described tract of limestone, about four miles west of Loudon, a deposit of iron ore occurs, formerly smelted in the old Mount Pleasant furnace near it, but now taken to Carrick furnace, four miles towards the north. The ore ranges, in greater or less abundance, for six or eight miles, in a narrow line along the south east base of the Tuscarora mountain, being procured in considerable quantity north of Carrick Furnace. Its position is near the contact of the limestone and overlying slate. It is of two varieties; one a hard ore, occasionally iridescent, making a rather cold-short iron; the other a "honey-comb ore," esteemed of much better quality. The analyses, showing their chemical nature, may be found in chapter VI.

The limestone employed as the flux in Carrick furnace, is procured

in part from a quarry adjacent to the works, and in part from the loose pieces scattered through the neighbouring fields. A little *pipe ore* has been occasionally found.

The narrow belt of slate which overlies the last mentioned range of limestone, occupies the base of Little Cove and Tuscarora mountains, rising nearly to their summits where it supports the sandstone rocks of F. IV. Passing west of Loudon and Fannetsburg by Concord, it extends into North Horse valley, between the Tuscarora and Conococheague mountains in Perry county.

The valley called the Little Cove, bounded by the Cove or Tuscarora mountain on the west, and the Little Cove mountain on the east, presents the strata in a synclinal or basin-like position, the two enclosing mountains consisting of the sandstone F. IV. Both margins of this valley are occupied by the red slates of F. V. seen near the foot of the bounding ridge. The limestone F. VI. encircles the Cove, inside of the red shale supporting in its turn F. VII. is two belts, the north-western ore forming a considerable ridge. The centre of the basin is occupied by the slates of F. VIII. the strata on the west side of the synclinal axis, dipping gently east, while those on the east side are nearly perpendicular. Among the bottom layers of this slate, occurs a highly important bed of iron ore used at Warren furnaces. It is a grey *proto-carbonate of iron*, precisely identical in chemical composition with the nodular and plate ores of the shales of the coal measures. The discovery of the true nature of this ore and of the exact place which it occupies in the strata, I regard as among the most useful of the developments of a practical kind made by us during the past year. I shall have occasion in describing the rocks of Huntingdon and Bedford counties, to allude again to this important deposit. Among the analysis in chapter VI. will be found that of this ore as it occurs in Little Cove.

SECTION II.

Of the Rocks of the Lewistown and Aughwick Vallies and their prolongations, embracing the belt of country extending from the Susquehanna river, to the Maryland line, and bounded on the south-east by the Shade, Black Log and Cove mountains, and on the north-west by Jack's mountain and Sideling Hill.

Lewistown Valley.—Adhering as far as practicable to the order of description adopted for all our formations, I shall proceed to the next most south-eastern belt explored, and trace it from the north-east towards the south-west. For convenience sake I have ventured to give the name of Lewistown Valley, to the belt of country embraced between Jack's mountain and Longstown ridge on the north-west, and Shade mountain and its prolongation, the Blue Ridge, on the south-east, extending the title to the whole of this well marked valley, from the Susquehanna to the Juniata, at Jack's narrows.

A series of narrow, nearly parallel ridges of inferior height to the

bounding mountains divides the general valley into several lesser ones, known by distinct appellations. Thus, a transverse line through Adamsburg, from Shade mountain to Jack's mountain, crosses three separate small vallies. That on the south-east, being the fertile limestone valley of Adamsburg, Beavertown, and Middleburg, that in the middle being the valley of Black Oak ridge, and that on the north-west, the fertile valley known as Moser's valley. These are all traceable to the Susquehanna. The Blue Hill at Northumberland, is a continuation of the Black Oak ridge, while Dry valley containing the town of New Berlin, is but a prolongation of Moser's valley. Along the Bellefonte and Lewistown turnpike, we observe first, the valley, in which Lewistown is situated, beyond this to the north-west another called Dry valley, which terminates a few miles north-east of the turnpike and beyond this again between the limestone ridge at Rawle's forge, and the foot of Jack's mountain, a third, known as Little valley, prolonged to the south-west of the turnpike under the name of Ferguson's valley and Long Hollow.

Formations. The mountain ridges which bound the belt on the south-east and north-west, are composed of the fourth formation of one lower secondary series, divided in my former annual reports into three distinct members. In Shade and Jack's mountains, the lower division of F. IV. is a hard compact sandstone of a greenish hue with some beds of a whiter variety, containing in its superior portion, layers of a reddish coarse conglomerate. The middle division is a red argillaceous sandstone, speckled with yellow *hydrated peroxide of iron*. The upper division is a compact sandstone of several shades of color, white prevailing, jointed into large massive, angular blocks. This last part of the formation usually forms the highest ridge of the mountain, the lower division occupying a bench on the flank of the mountain, often one-third of its height from the summit. In Jack's mountain, these lower rocks form the bench along the south-east side of Kishiequillas valley, but in Shade mountain only the upper member of F. IV. can be observed, the anticlinal dip of the strata placing it upon the flanks of the ridge, which for most of its length consist of three parallel summits, the central one being constituted of the lower sandstone member of the formation. The whole thickness of F. IV. as it occurs in these mountains is probably about fifteen hundred feet.

The hard grey sandstone of F. IV. graduate by a series of alternations with layers of compact red sandstone into the red and variegated shales of F. V. This last important stratum, together with the limestone F. VI. which it supports, constitutes the most fertile and valuable tracts of the general belt before us. Besides, containing bands of compact and good limestone; F. V. includes in its upper division, which is several hundred feet thick, a soft calcareous shale which readily disintegrates and forms one of the richest soils of the State. The alternating red and grey sandstones at the base of the formation, are sometimes argillaceous, when they can be split and shaped into excellent flag-stones. Some of these abundantly covered

with the fossil remains of the marine vegetation, called *fucoides* have been much employed for the side walks of the streets of Lewistown.

The next division of F. V. is highly argillaceous. The hills composed of it constituting a peculiar feature in the topography not only of this valley, but of the whole district to be described. The lower layers consist of a thin argillaceous brown sandstone, full of the remains of *trilobites*. These support a thick mass of olive and buff colored shales, highly fossiliferous, and upon these reposes a sandstone of variable thickness, but of well marked characters, demanding particular notice, as furnishing our best guide to the exact position of the *fossiliferous iron ore*, which confers so much interest upon F. V. in an economical light. This sandstone and the ore invariably occur in close proximity to each other. The prevailing aspect of the stratum is that of a rather coarse grained, dirty white and yellowish sandstone, containing fragments of *Encrini* and other fossils. It frequently constitutes a small ridge of itself. It may be studied in a fine exposure south of Simon Gros' house, near Shade mountain. It is exposed in many other places, as at the north base of the chain of slate hills, south of Adamsburg and the slate hills, one and a half miles south of Middleburg, where large detached fragments of it abound. These present upon their surface, numerous impressions of *terebratula* and other fossil shells. The *fossiliferous ore* usually rests almost immediately over this bed of sandstone. Above the ore reposes a series of olive and green shales supporting the limestone layers of the formation. Between the Susquehanna and the Lewistown turnpike, these bands of limestone are generally argillaceous or siliceous, and therefore rarely furnish pure lime.

Above the limestone occurs the main bed of red shale and sandstone of the formation, in some places including very hard bands of green and reddish sandstones, breaking into cuboidal fragments. Ascending, the red shale becomes calcareous and alternates with a soft greenish variety which is decidedly calcareous, containing indeed towards its upper portion some thin bands of limestone. This part of the formation is about five hundred feet thick in the vicinity of Lewistown, and furnishes much of the richest soil of the valley. The total thickness of the entire formation is apparently between three and four thousand feet. It occurs along the base of the mountains, forming the hills immediately adjacent to them. It likewise constitutes a belt in Little valley, Dry valley, Moser's valley and the valley of Middle creek.

Overlying the shales of F. V. is the valuable limestone F. VI. of our series. This is the rock of all the limestone ridges throughout the valley. The lower beds are too argillaceous and slaty, to produce good lime, but those higher in the formation supply it of great purity. Near the top of the stratum are bands of very siliceous limestone, abounding in fossils and layers of compact *chert*. This upper division of the rock is frequently too siliceous to be converted into lime. The bed of *chert* is of variable thickness, being sometimes twenty

feet in depth while sometimes it is wholly missing. Its position is generally on the tops and sides of the limestone ridges, its angular fragments covering the surface. On the road from Adamsburg to Shroyer's, it is thirty feet thick.

Immediately resting upon the chert or removed from it but a short distance, are the loose and porous layers of yellow sandstone at the bottom of F. VII. The whole stratum appears to thin out towards the Susquehanna, for here we find only a trace of it, while on the Lewistown turnpike at the toll gate it is seventy feet thick, presenting itself on the surface as usual in massive blocks full of the cavities left by the dissolution of its fossils. The bed itself is not distinctly traceable more than twelve miles north-eastward from Lewistown, but fragments of the rock are seen adjacent to the limestone, at intervals the whole way to the Susquehanna, implying however, that it either is not continuous or is very thin. This sandstone caps nearly all the limestone ridges of the valley from north-east of Lewistown, to Huntingdon county.

Supported by the sandstone beds of F. VII. is a thick mass of slaty rocks, which constitute F. VIII., forming some of the ridges of the central part of the valley; for example, filling a large part of Black Oak Ridge valley to the Susquehanna. The lower part of F. VIII., near its contact with F. VII., sometimes contains a coarse, siliceous and fossiliferous bed of limestone. This is visible on the road crossing the Toll-gate ridge from Lewistown into Dry valley. Above this siliceous limestone, on the flanks of the slate ridges, layers of a purer variety of limestone are occasionally discerned, as at Mr. John Miller's, on Jack's creek. The thickness of this last mentioned belt of limestone is sometimes thirty feet.

In the lower portion of F. VIII. we often meet with a thick series of highly calcareous layers, which sometimes contain bands adapted for making *hydraulic cement*. These beds, which for convenience I have denominated the *cement layers*, are not invariably present in the formation. They are well exposed on the eastern shore of the Susquehanna river, directly opposite Selinsgrove; but between the river and Lewistown, they are scarcely discernible. The limestone previously mentioned is likewise somewhat inconstant. The title of *olive slate* given to F. VIII. in my earlier reports, is entirely applicable to the formation in the belt of country before us. Besides the greenish grey and olive colored slates which make up a large portion of the rock, occur beds of grey sandstone, and occasionally of a massive and compact blue sandstone, slightly calcareous in its composition. These are seen on the road from Lewistown to Sigler's, on Jack's creek. The strata forming the alternations of the materials of F. VIII. and F. IX. are observed as far to the south-west as a line drawn from Middleburg to Centreville. The red and grey argillaceous sandstones of F. IX., so finely exposed on the Blue Hill opposite Northumberland, extend about ten miles south-west of the river, gradually contracting to a point.

From Lewistown, south-ward, the same general valley extends for nearly forty miles, bounded on the north west by Jack's mountain, and on the south-east by Blue ridge, and beyond the termination of that, by Black Log mountain. Its average width is between four and five miles. Approaching Huntingdon county, the whole belt curves southward, conforming to the direction of Jack's mountain. Between Lewistown and the termination of Blue ridge, the general structure of the valley is that of a synclinal basin, including the strata from the bottom of F. V. to the middle of F. VIII., thrown into a number of exceedingly regular parallel lesser anticlinal and synclinal axes, the exact tracing of which becomes a matter of considerable importance from the intimate relation which subsists between them and the distribution of the iron ores of the belt.

Blue ridge terminating at Bell's furnace, its axis of elevation is prolonged seven miles further south-west, being successively overlaid by higher and higher strata, until it flattens away in F. VIII. at Orbisonia. Here the narrow synclinal axis, lying south of it, extending from Negro valley, merges into the general synclinal axis south-east of Jack's mountain; there forming one general trough between Black Log and Jack's mountains, containing the north-west and south-east dipping rocks from F. V. to F. IX. inclusive.

Commencing our description of the several formations of the belt with a brief sketch of the topography of the district, the most conspicuous ridges which we observe occupying the north-eastern end of the valley, at the Susquehanna, are the Blue Hill and the slate ridges adjacent to it on the north and south. These present a range of bold cliffs along the western side of the river. They form a belt extending from two miles above Northumberland to within a mile of Selinsgrove. These hills occupy the central portions of the valley from the river to within eight or nine miles of the Lewistown turnpike. Their outlines are highly characteristic of the formations VIII. and IX. which compose them. Their summits are usually gently rounded, their whole contour undulating, and their flanks intersected by innumerable little transverse vallies of denudation, the slopes on each side of which are of remarkably regular curvature.

The northern limit of these grey and red slaty rocks is immediately south of the limestone ridge which extends through Dry valley and Moser's valley, just south of the towns of New Berlin and Centreville, and on to David Muthbaugh's, where they terminate, a small belt of F. VIII. only continuing to the north of Dry valley. The southern limit, leaving the river about a mile north of Selinsgrove, ranges to Middleburg, bordering on the north the limestone ridge which extends past Middleburg, Beavertown, and John Sigler's. From Middleburg it continues, bordering a narrow belt between the limestone ridge and Dry valley, to the Lewistown turnpike at the toll gate.

On both sides of the hills of F. VIII. we observe the limestone ridges generally covered with fragments of the chert at the top of F. VI. and as we advance towards Lewistown, they become capped

with beds of the fossiliferous sandstone or F. VII. These limestone hills have the form of continuous ridges for many miles. These are occasionally interrupted by gaps, and oftentimes entirely washed away, by denudation, for one or two miles. In Dry valley, in which New Berlin is situated, F. VI. occurs, though not in a bold and continuous ridge. Tracing this limestone, however, towards Centreville, we may often notice it assuming the magnitude of a moderately elevated narrow hill, and preserving this feature through Moser's valley. About nine miles from Centreville, a second and bolder ridge of this formation shows itself, continuing south of Mr. William Smith's, and thence near the base of Shade mountain, until it is interfered with by the axis of elevation of Little valley and Dry valley. Another ridge of the same limestone, ranging south of the slate hills of F. VIII. commences at the Susquehanna, a mile north of Selinsgrove, though other belts occur nearer the town, and runs through the valley of Middle creek, passing north of Middleburg and Beavertown, where another hill rises near it, and then passes Adamsburg, to sweep in a regular curve towards Shade mountain. Here it passes the farms of Mr. John Sigler and others, westward. From Adamsburg, westward, it is the most southern limestone ridge of the whole valley. Its outline is very regular; and its surface, cultivated nearly to the summit, presents a beautiful scollop, constituting a conspicuous and pleasing feature in the scenery. In addition to this ridge, two very singularly shaped knobs of the limestone rises between Middleburg and Beavertown, visible from nearly every part of the valley. In each of them, the rocks have a trough-like or synclinal arrangement. The summit of the southern knob is the broadest, and is under cultivation. These knobs owe their elevation to short axes or wrinkles in the strata.

Approaching Lewistown, the ridges composed of the limestone and overlying sandstone become more numerous, dividing the district into several lesser fertile vallies to be alluded to hereafter.

The hills consisting of that division of F. V. comprising the blue grey and olive coloured slates have a somewhat peculiar topography. Their outline is irregular and even ragged. They fold round the ends of Jack's mountain and Shade mountain encircling them at the base. They embrace then usually three summits, the central or broadest, containing the prolongation of the axis of the mountain. Two of these slate hills range along the northern base of Shade mountain, with rather vaguely defined summits from nearly opposite Middleburg, to about two miles east of Beavertown, becoming conspicuously marked from thence to a point three miles west from Adamsburg, leaving the mountain in consequence of a great curve which it takes while they maintain their nearly straight direction. From the above point, to Lewistown, they are less prominently defined in the scenery owing to their close proximity to the mountain. From some cause, no corresponding ridges range parallel with the southern base of Jack's mountain. Enumerating as concisely as possible the several axes of elevation which traverse the belt from the Susquehanna southwest-

ward; the first is the anticlinal axis of Longstown ridge which brings to the surface near its summit the red and grey alternating beds of Fs. IV. and V. This axis prolonged enters Jack's mountain. South of this, the next axis observable on the Susquehanna is the great synclinal depression of the strata controlling the structure of the whole valley. It commences at the river in the Blue Hill, forming a basin in the red rocks of F. IX. and extends southwestward centrally until the uppermost rocks are the slates of F. VIII. It passes about two and a half miles north of Middleburg. Parallel with this is the anticlinal axis observed about a mile north of Selinsgrove, which has lifted the limestone F. VI. to the surface. This is probably but the prolongation of the main axis of Shade mountain marking the line along which the rocks of that ridge have undergone their greatest elevation.

Moser's valley consists chiefly of F. V. and includes two limestone ridges of F. VI. The northern of these seems to be the continuation of that which runs south of Centreville, prolonged with occasional interruptions to within a mile of Mr. John Troxell's, while the southern more elevated ridge ranges far beyond Shroyer's. An anticlinal axis has evidently lifted to the surface the underlaying stratum F. V. occupying the narrow belt between them. There is an anticlinal axis in Middle creek valley ranging near Middleburg, lifting to the surface the red shale of F. V. about a mile and a half from the town, but not bringing up the next lower division of the formation containing the *fossiliferous iron ore*. West of south, a little distance, from the town it brings to view the green calcareous shales of the formation. It is thence prolonged between the northern insulated knoll of limestone and the ridge immediately north of Middleburg, disappearing between Beavertown and Adamsburg. A short anticlinal axis elevates the rocks between the pair of limestone knolls and the southern solitary knoll. The effect of the dying out of these axes is to bring the limestone ridge north of Adamsburg, nearer to the foot of the Shade mountain where it finally vanishes.

A new group of axes of elevation present themselves when we approach within ten or twelve miles of the Lewistown turnpike. The first of these ranging about half a mile from the foot of Jack's mountain brings to the surface the red shales of F. V., the second, the calcareous shales along the centre of Dry valley, lifting into view some useful belts of limestone. The third extends along a small valley north of what we have called the "Toll-gate ridge," and the fourth ranges immediately past Lewistown. The most northwestern of these, crossing the Kishicoquillas creek, above the forge of Messrs. Hall and Rawle, is prolonged for about eighteen miles, ranging through Ferguson's valley and terminating in the north-east end of Long hollow. The next towards the south-east crosses the creek about three-fourths of a mile south-east of the former and traversing the ridges which bound Ferguson's valley, passes a fourth of a mile north of Hope, and half a mile north of the Waynesburg furnace, to terminate also near the head of Long hollow. South-east of this, another axis lift-

ing the strata, originates about two miles north-east of Hope furnace, and extends south-west for nine miles passing immediately by this and Waynesburg furnace, to disappear two miles south-west of the latter in the head of Greenbriar valley. The next in order, the third upon the turnpike, crosses Kishicoquillas creek three-fourths of a mile south east of the second, and passing a mile and a half north-west of Lewistown. Its course thence is about twenty miles, ranging three hundred yards south-east of Waynesburg, and ending two miles north of Newton Hamilton at Glasgow's mill. The fifth axis of the group, passing half a mile south-east of Lewistown, ranges south of Strode's mill, forming a ridge running thence nearly a mile south of Waynesburg and through the town of Newton Hamilton, beyond which it terminates. The sixth and last of these lines of elevation, is a continuation of the anticlinal axis of Shade mountain. From the point where this ridge subsides south-east of Lewistown, the axis which has upheaved the strata along its summit, is still prolonged, elevating other rocks for twenty-eight miles to the south-west. It passes two miles south-west of Waynesburg and a mile and a half south of Newton Hamilton, crossing the great loop of the Juniata, and ranging close south of the outlet of Aughwick creek, ending finally at Shirleysburg. Between the fifth and sixth lines of elevation, another axis originates opposite Newton Hamilton which becomes that of Prater's ridge, uplifting there the sandstones of F. VII. The inclination of the several belts of rocks uptilted along these lines of elevation is usually steep and as a consequence, the general valley consists of a number of parallel belts of formations V. VI. VII. and VIII., the softer or more readily denuded of these occupying the vallies, the harder and more resisting composing the intervening ridges.

Iron ores. Having now given a brief sketch, as minute as was compatible with the present report, of the range of the several formations in this belt. I shall proceed concisely to describe the indications of iron ore which they exhibit. The *fossiliferous iron ore* of F. V. is by far the most continuous variety, though after careful investigation we have no where discovered it either pure enough or in sufficient abundance to make it an object of economical interest. It exhibits only occasionally the square fracture characteristic of its purer bands near the outcrop. This feature it has near N. Middleswarth's mill race near Beavertown, but generally it breaks into roundish pieces and consists of much sand cemented by yellowish brown oxide of iron.

A thin seam of this ore extends along the north side of the valley following the flank of Jack's mountain beneath the red shale. It must necessarily cross Kishicoquillas creek, but the thinness of the band has prevented our finding it there, though the hard encrinurite white sandstone so usually associated with it appears well exposed and was extensively traced. The ore seam was not found in place until F. V. was followed into Moser's valley, where the outcrop was detected in a field belonging to Mr. Andrew Romick. The position of the ore in this valley appears to be immediately above the narrow

belt of hard sandstone. Being of the composition above described its quality is bad. Its thickness, probably unimportant, was not ascertained. The same sandstone ridge ranges past the farm of Mr. John Featherolf, accompanied by the ore of too impure a quality, however, to be valuable. Its course eastward ought to be along the base of Longstown ridge, but our efforts to trace it were unavailing, while from observations made during both the past season, and the previous one, in Union county we are led to conclude that it is invariably too thin and impure to be productive. The ore again rises to the surface occupying its usual place in the formation along the south side of the valley adjacent to the base of Shade mountain. We detect it in its true position in a beautiful section of the strata at Mr. Ner Middleswarth's mill. The excavation in the mill race shows the encrinitic sandstone supporting the fossiliferous ore in the form of a very hard and siliceous sand from four to six inches thick. Above the ore rests a mass of greenish shale about one hundred feet thick and over this a somewhat variable shale of a cherry red colour sustaining in turn a series of calcareous shales occupying the place of the limestone bands of the formation and supporting the well known brownish red shales at the top of the series. No difficulty existed in tracing the ore along the base of the slate hills south of Adamsburg and Beavertown, and it was also followed along the foot of the slate hills south of Middleburg, but it is rarely of sufficient purity, and in no place thick enough to make it practically useful. Near Lewistown, especially seven miles to the west, it has been opened in many places, and its thickness though increasing in that direction is even there not considerable.

Another distinct band of ore occurs sometimes in F. V. among the buff and olive shales already described. It is of a light brownish colour, and is generally too small in amount and too impure, to be valuable.

The limestone ridges of F. VI. frequently exhibit considerable quantities of iron ore upon the surface; yet, from the shallow depth of the earth above the rock, and from other indications, we deem the prospect a slender one of finding a useful deposit in this formation as it occurs in Union and Mifflin counties. This superficial display of ore is visible on the ridge north of Adamsburg, and also on one of the isolated knobs near Beavertown.

No useful quantity of ore would seem to occur in either F. VII. or F. VIII. north-east of the Lewistown turnpike. The first of these formations dwindles in thickness as it approaches the Susquehanna, and also is much less ferruginous than in Huntingdon and Bedford counties.

F. V. South-east of Lewistown.

Lewistown is situated on the border of F. V. and F. VI. or of the shales and limestone, F. V. occupying the entire space from the town to the base of the mountain south-east of it, called Blue Ridge.

This belt is at least one mile and a half wide, and continues of this breadth as far as Waynesburg. At Lewistown, the stratum have been lifted to the surface by two anticlinal axes, while opposite Waynesburg it is thrown up in three lines of elevation. The first of these, south of Lewistown, begins to form a ridge east of Strode's mill, which continues for six miles, ending south of Waynesburg. This ridge is composed of the fossiliferous sandstone belt of F. V. and has the fossiliferous iron ore resting on both of its flanks. South-east of Waynesburg, the limestone F. VI. lies in the synclinal axis. South of the anticlinal axis, and three miles south-west of the same town, F. V. with the fifth anticlinal axis in it, is overlaid by the limestone.

The anticlinal axis of Shade mountain, in elevating F. V. brings the fossiliferous iron ore to the surface, in a double line of outcrop, for a mile and a half south-west of the end of the mountain, beyond which the ore sinks below the surface—the axis exposes the higher parts of F. V. for about fifteen miles, when the red shales disappearing altogether, it is prolonged in the limestone beds of F. VI., entering this formation opposite Galloway's Gap, in Blue Ridge. The limestone forms a trough between this axis and the mountain, commencing between four and five miles east of this point and extending to the bend of the Juniata, a narrow ridge of the overlying sandstone of F. VII. rising near Galloway's Gap, and running along the centre of the basin to the river.

The belt which ranges along the base of Blue Ridge being separated from the other belt elevated by the Shade mountain axis by this tract of limestone, ranges towards the south-west, passing Bell's mill, and finally folds round the end of Blue Ridge, to enter the synclinal basin of Negro valley. The rocks of this formation, resting at the foot of the mountain, extend about one-third of the way up its declivity, and spread into the valley a few hundred yards from its base, dipping to the north-west, at an angle of about fifty degrees. Where it saddles the axis of Blue Ridge, it lengthens itself to the south-west so as to form a considerable portion of Germany valley, the hard sandstone stratum forming a curious semicircular ridge sweeping round the end of the mountain. In Negro valley, this formation lies in a trough, or, in other words, its strata dip from both sides towards a central line or synclinal axis, being elevated on the north-west by the anticlinal axis of Blue Ridge, and on the south-east by that which has uplifted the Black Log mountain. Nearly opposite the end of Blue Ridge, the upper strata of F. V. are overlaid in the middle of the basin by the next succeeding formation, the limestone. The north-west dipping beds of F. V., resting at the base of Black Log Mountain, form a belt which ranges with great regularity along its flank for eighteen miles, to Fort Littleton. The mountain then terminating, the zone of red shale is joined by another which follows the south-east flank of Shade mountain, and the two fold together at Littleton over the anticlinal axis prolonged from Black Log valley, forming a tract of good soil, occupied by several farms.

FORMATION V.—*North-west of Lewistown.*

The formation at Brown's gap, where Kishicoquillas creek passes through a deep notch in Jack's mountain, is about a mile and three-quarter's wide, forming the north-west side of Ferguson's valley, and extending half way up the slope of the mountain. This belt of F. V. is traversed by the first anticlinal axis of our enumeration, which lifts to the surface the *fossiliferous* ore about two miles south-west of the gap. The existence of the ore is indicated by a ridge extending along the north-west side of Ferguson's valley, and which consists of the grey sandstone stratum of F. V., immediately supporting the ore. The anticlinal axis running along the centre of this little ridge of sandstone, the fossiliferous ore is brought up in a double line of outcrop, one portion resting on each flank. The ridge extends south-west between five and six miles, where the gentle subsidence of the strata over the axis causes the ore to disappear below the surface; and two miles further south-west, the whole of F. V. itself, along the line of the axis, also passes out of view, being overlaid by the limestone. For some distance previous to the disappearance of the red shales along this axis, the limestone occupies a narrow trough between this range of the formation and the other which rests against the foot of the mountain. This latter belt of F. V. its beds dipping about thirty degrees towards the south-east, continues along the slope and base of Jack's mountain for about nine miles, when it begins to recede from its flank so as to rest only at the mountain's base when we reach Drake's ferry. This portion of it, therefore, forms the north west part of the valley called Long Hollow, the strata here dipping twenty-two degrees to the south-east.

Traced south-westward from the Juniata, F. V. occupies the north-west side of Dry valley—a valley lying between Jack's mountain and Chesnut ridge. Here its beds dip thirty-five degrees to the south-east. It preserves this position at the base of the mountain, which it follows to its termination, about fifteen miles, folding round its south-western end, at the Three Springs, to meet a parallel belt occupy the other base of the mountain in Hare's valley. Where the formation climbs some distance up the flank of the mountain, the hard grey sandstone forms a slight but distinct ledge along its slope; but where it rests only at the base, this band constitutes a sharp-crested ridge, ranging through the south west end of Long Hollow, and traversing the north-west side of Dry valley for a considerable distance.

Fossiliferous iron ore of F. V.

With a single exception, all the furnaces situated in the belt of country before us from Lewistown to Maryland, being nine in number are supplied with two varieties of iron ore. One of these is the fossiliferous ore for the formation above described. The other belongs to

the lower layers of F. VIII. to be hereafter noticed. Their distribution being entirely dependant on minute features in the geological structure of the valley connected with the axes of elevation, the work of tracing then becomes a matter of systematic research, making a correct knowledge of the position of the strata and their axes, of indispensable importance.

Confining ourselves for the present to the fossiliferous ore of F. V. I deem it useful again to allude to its close association with the grey fossiliferous sandstone which forming often a prominent feature on the surface proves so valuable an index to its position. Generally throughout the belt of country before us, the uppermost layer of this sandstone is a hard bed varying from fifteen to thirty feet in thickness, consisting sometimes of a fine grained white or yellowish brown rock, filled with numerous cavities of *encrini* and other fossils.

The fossiliferous ore besides cropping out in a narrow line following the flank of each of the mountains bounding the general valley, is lifted to the surface for a certain distance along two of the anticlinal axes which traverse the district between Lewistown and the Juniata at Drake's narrows. The belt of ore on the flank of Jack's mountain has not been opened north-east of Drake's Gap. Here however, it has been smelted in Matilda Furnace, making a good iron. At this place the whole thickness of the seam of ore is about sixteen inches, the upper half, only, however, being pure enough for the furnace. This, averaging about eight inches in thickness, is very similar in aspect and composition to the ore of acknowledged excellence in other parts of the same deposite, being hardly distinguishable from that of Montour's Ridge, or that of Woodcock valley at the base of Tussey's mountain. It is rather less rich in iron though in other respects quite as good. This belt of eight inches is separated by a band of three or four inches of tough greenish slate from a lower layer of nearly equal thickness, containing only about half the proportion of iron in the former and consisting largely of sand and other extraneous matters. Though possessing somewhat the aspect of the true fossiliferous ore above it, it is too siliceous and too poor in metal to make it useful, even for mixing with the richer ore. The two analysis given in chapter VI. will show the composition of each of these divisions of the ore bed at Matilda furnace.

The same bed of ore presenting very nearly the same features occurs in Dry valley, south-west of the Juniata. One of the belts thrown up by the anticlinal axis of the north-west side of Ferguson's valley, has been opened at several points for the supply of Hepe furnace. It is the southern dipping band, the northward dipping ore being very steep which as a general rule somewhat lessens the value of the stratum.

The ore brought up to the surface by the fifth anticlinal axis of the valley extends from a point south-east of Strode's mill, to a point south-east of Waynesburg, accompanying the usual ridge of sandstone. The bed in this range is not more than four or five inches thick, but resting upon the upper layers of the hard sandstone and overlaid by

a very shallow covering of soft shale it is readily accessible. In some places it nearly saddles the axis of the ridge near the north-east extremity, of which several excavations have been made; the ore is used at Hope furnace.

The band of ore extending along the north-west flank of Blue Ridge has not been opened between Lewistown and Bell's mill. Near the latter place the Juniata cutting the belt of sandstone at the bluff called Blue Rock, exposes the ore which exists here in two thin layers not of sufficient magnitude to be valuable. At Bell's furnace the same layers as they sweep round the termination of Blue Ridge have been worked, though their insufficient thickness has caused them to be abandoned.

F. V. in Pigeon Cove.

Pigeon Cove, commencing in the southern part of Bedford county, and extending into Maryland, is a small valley of elevation consisting of F. V. bounded on all sides by a rim of hills composed at their base of the limestone F. VI. Its length in Pennsylvania from the State line to the head of the valley is between six and seven miles, and its width at the Maryland line is about a mile and a half. The axis of elevation which has upheaved the shales of F. V. along the middle of this valley and caused the adjoining strata to dip away in opposite directions, is apparently a prolongation of the great axis of Black Log valley, which there brings to the surface a much deeper seated set of rocks. Had the uplifting action been only a little more powerful, on the denudation deeper in Pigeon Cove, there can be no doubt that a valuable band of the fossiliferous ore would have been exposed, inasmuch as further to the south in Virginia, where such a state of things prevails the bed reaches the surface in two parallel lines of outcrop. As it is, only the superior portion of the formation lying above the ore is exposed.

F. V. at the base of Scrub Ridge.

The red and variegated shales of F. V. probably exist in a perpendicular attitude at the base of Scrub Ridge, extending from the Burnt Cabins for six or seven miles towards the south-west, where they are lost below the surface in consequence of an enormous dislocation of the strata which extends along the north-west side of the McConnellsburg Cove. They emerge again south-west of Hunter's mill, and thence extend along the flank of Dickey's mountain, to its termination, folding round to meet another belt of the same formation, which occupies the north-west side of the Little Cove.

F. V. in Little Cove.

A wide border of F. V. encircles the valley called Little Cove. Commencing high up on the slopes of the Cove mountain, just where the Chambersburg turnpike ascends it, north of Loudon, the formation ranges along the trough or synclinal axis of the valley in a S. S. W. direction between nine and ten miles, where the deepening of the basin permits the red shales to be overlaid along the south-eastern side, by a belt of limestone, F. VI. which divides it into two zones. That on the north-west is broad, its strata having a rather gentle inclination to the south-east, about thirty degrees, the formation spreading over a considerable portion of the north-west side of the cove. Towards the south-west this gradually contracts and finally unites as before mentioned with the belt which sweeps round the end of Dickey's mountain near the State line. The other or south-eastern zone is narrow and extends high up on the flank of the Little Cove mountain, its strata being nearly perpendicular.

Formation V. as it appears in Little Cove, includes two important beds of sandstone, each nearly one hundred feet thick, separated by about the same thickness of olive and yellowish beds of shale. The lower of these is a red sandstone, the upper, a white sandstone, and the position of the *fossiliferous iron ore*, is in the shales which lie between them. These belts of sandstone constitute the ridge along which the turnpike ascends from a mile north of Loudon to the toll gate on Cove mountain. Along the north side of Little Cove, they likewise range in a high ridge, upon the east of which the *fossiliferous ore* was traced for eight or nine miles south-west, from the Mercersburg turnpike. On the south-east side of the Cove, these sandstones do not give rise to a separate ridge but rest high up in the slope of the bounding mountain.

The *fossiliferous ore* thus discovered cropping out along the north-west side of the synclinal axis of Little Cove, was traced by the fragments scattered on the surface for nearly fifteen miles.

FORMATION VI.—*Fossiliferous Limestone.*

F. VI. from Lewistown to Fort Littleton. Between the first and second anticlinal axes north-west of Lewistown, occurs a synclinal axis in the *fossiliferous limestone* F. VI. which forms a high ridge on the Bellfonte turnpike. The second or northern anticlinal axis, lies also in the limestone. But about a mile towards the south-west the sandstone F. VII. begins to occupy the line of the synclinal axis separating the limestone into two belts. That on the north-west, bordering the south side of Ferguson's valley, and continuing for nine or ten miles, ranges at the base of the sandstone ridges, until nearly opposite Waynesburg, where it folds into the limestone of the basin north of it, saddling the northern anticlinal axis coming out of Fer-

guson's valley. This belt is thence prolonged to the south-west about two miles further where a ridge of sandstone begins to overlie the northern side of it, subdividing it for about four miles, into two narrow tracts and then ceasing in order to allow these to reunite at the north-east end of Long Hollow.

The second anticlinal axis counting southward from the mountain, elevates to the surface a narrow belt of the limestone varying from two to six hundred yards in width, and extending from a point north of Lewistown to Atkinson's mill, a distance of eighteen miles. For a portion of this distance it forms the crest of a ridge flanked on each side by the sandstone beds F. VII. About a quarter of a mile north-west of Waynesburg furnace, this ridge has been cut down by denudation into a little valley about two miles in length. At Atkinson's mill in the east end of Long Hollow the narrow ridge of sandstone lying between this limestone and another belt of the same rock on the north ceasing, the two merge together into a broad tract, nearly a mile in width, having two anticlinal axes near its eastern end which die out two or three miles to the south-west in Long Hollow. The limestone extends along the south-east side of this valley dipping only in one direction, or towards the south-east. Where the belt reaches the Juniata, it is half a mile wide. Traced still further towards the south-west, it forms the south-east side of Dry Valley, and reposes at the base of Chesnut Ridge under the sandstone F. VII. Preserving a gentle dip it advances about fifteen miles beyond the Juniata, to the Three Springs where it folds over the red shales which saddle the axis of Jack's mountain and meets the belt that in a similar manner traverses Hare's valley.

The third anticlinal axis counting from the mountain, which does not appear on the Bellefonte turnpike brings into view a narrow belt of the limestone, commencing about two miles north-east of Hope furnace. In its course towards the south-west it passes under this furnace and also under the Waynesburg furnace, ending a mile and a half south-west of the latter. It is overlaid on each side and at both ends by the sandstone F. VII. constituting the crest of a ridge a few hundred yards in breadth while the sandstone forms the flank.

The fourth anticlinal axis develops the limestone a little north of the toll gate near Lewistown. This rock then constitutes the crest of a ridge flanked on both sides by the sandstone. Its width is between three and four hundred yards. About five miles south-west of Lewistown, it merges into the next adjacent belt of limestone which passes immediately by Lewistown. The synclinal axis or trough between the ranges is occupied by the sandstone capped by the slates of F. VIII, which there cease. The limestone beyond this point consisting of but one narrow belt, ranges north of Strode's mill and south of the sandstone ridges passing the town of Waynesburg, a mile beyond which it again widens and finally divides into two projecting points or tongues by the commencement of a broad ridge of sandstone lying in the synclinal trough between the fourth and fifth anticlinal axis. The north western range runs for a mile and a half and

then disappears beneath the overlying sandstone about four miles south west of Waynesburg. The south-eastern portion ranges about four miles further, following the fifth anticlinal axis along which it joins another belt of the same limestone which commences south of the Juniata about two and a half miles east of Waynesburg. The broad belt formed by the union of these two, is a second time subdivided by a ridge of sandstone, at a point near the canal about five miles below Newton Hamilton, the northern prong running to a point between sandstone ridges about a mile and a half to the west, while the southern division extends in a regular belt to the great bend of the Juniata. This latter range when opposite to Galloway's Gap, is joined by another occupying a narrow trough at the foot of the mountain which commences about three miles south of Waynesburg, and half a mile south-east of the river. This last and most south-eastern belt containing a synclinal axis embraces along its centre a narrow ridge of the overlying sandstone commencing opposite Galloway's Gap and running to the bend of the Juniata, dividing the limestone into two vallies. That next the mountain called Sugar Valley, is the narrowest. The limestone ranging along the north-west side of this ridge and between it and another sandstone belt following the Juniata, gradually contracts in width towards the bend of the river, which it crosses one mile south of Newton Hamilton passing the mouth of Aughwick creek and becoming the crest of Owen's ridge. It ceases altogether about a mile north-east of Shirleysburg, where it is overlaid by the sandstone F. VII.

Prater's ridge, consisting of the limestone and overlying sandstone, owes its elevation to an anticlinal axis, developed in the latter. It commences south-east of Newton Hamilton, and extends for about three miles, running close to the north-west base of Owen's ridge, forming a narrow trough or synclinal valley of F. VIII. between them.

The subdivision of the limestone which traverses Sugar Valley, crosses the bend of the Juniata north-west of Bell's mill, beyond which it borders the north-west side of Germany valley, at the south-east base of Owen's ridge. At the western extremity of Germany valley, three miles from the end of Blue ridge, the zone of limestone closes over the anticlinal axis prolonged from the mountain, and sweeps round towards the east and forms a basin at the mouth of Negro valley. Thus augmented in breadth, in curving round the head of Germany valley, it becomes soon subdivided, by receiving in the middle of the basin, south of the end of that valley, a sandstone ridge of F. VII. separating it into two distinct belts towards the south-west. The most northern of these ranges three miles from the commencement of the ridge, and finally disappears, one mile north-east of Orbisonia, in the anticlinal axis, where it is saddled by the sandstone. The other, or south-east division, ranges towards the south-west, with great regularity, for fourteen miles, following the base of Black Log mountain. It passes north of Winchester furnace and

south-east of Madden's mill; and about a mile south-west of Littleton, it meets the belt which pursues the south-east base of Shade mountain.

F. VI. at the Foot of Scrub Ridge.

At the Burnt Cabins, near the line of Bedford county, the limestone is seen in a perpendicular position, extending along the north-west side of the prolongation of the anticlinal axis of the cove. It probably continues south-west for six or seven miles in that altitude, until lost in the great dislocation, before referred to, at the base of Scrub Ridge. It emerges again on the north-west flank of Lowrey's knob, and passes thence a short distance south-east of Hanover furnace, and along the base of Dickey's mountain, where it passes into Maryland, and finally folds round the end of that ridge, saddling its anticlinal axis, and uniting with the north-western belt of the formation in Little Cove.

F. VI. in Little Cove.

The limestone begins to show itself along the south-east side of the Little cove, south-west of the Mercersburg turnpike, and extends down the cove for several miles, when the overlying sandstone commencing, it divides, one belt crossing the cove westwardly to follow its north-western side, the other belt preserving a steeper dip, running along the south-east side of the base of the Little Cove mountain. The first range passes three-fourths of a mile north-west of Warren furnace, and crosses the State line at the base of a ridge capped by the sandstone.

Pigeon Cove is belted on both sides by this limestone, having its usual fossiliferous character. It forms the base of the enclosing hills, called the Conolloway ridges.

Iron Ore.

This limestone formation has been carefully examined throughout the several belts here described, with a view, if possible, to discover workable deposits of iron ore. In many places, indeed, it exhibits in the soil scattered lumps of a compact chesnut brown ore, of excellent quality; but the shallowness of the earth resting over this rock, and other causes, seem to have prevented the accumulation of large deposits, such as we find in the great belts of limestone belonging to F. II. Somewhat extensive accumulations of ore do occur in the ridges at the base of which this limestone usually lies; but these are subordinate rather to the sandstone F. VII., which caps those ridges, than to the underlying limestone. They will be mentioned, therefore, in the next section.

FORMATION VII.—*Fossiliferous Sandstone.*

Formation VII. from Lewistown to Maryland. In the belt of country at present before us, this sandstone is of no great thickness, varying from fifty to one hundred feet. Its lower beds consist of an argillaceous buff coloured sandstone, in which the siliceous particles, though abundant, are often of extreme minuteness. Its colour is yellowish or buff, and it breaks into rectangular fragments. Its upper portion, on the contrary is a coarse grained sandstone, usually white or brownish. Wherever this formation appears, it almost invariably constitutes a sandy and rugged ridge. The most north-western ridge of this formation, lying near the foot of Jack's mountain, commences two miles north-west of Waynesburg, and terminates one mile north of Atkinson's mill. The next begins about a mile south west of the Bellefonte turnpike, and ranges for seventeen miles, including, probably, in its trough, a narrow belt of F. VIII. for most of this distance. It bounds Ferguson's valley on the south-east, passes north-west of Hope furnace, thence by Huling's saw-mill, and ends north of Atkinson's mill, near one of Mr. Patton's ore banks. The third belt commences about a mile north-west of Lewistown, and separates into two ridges, about two miles north east of Hope furnace. That on the north-west, embracing a narrow strip of the slates of F. VIII., passes north-west of the furnace and a few hundred yards north-west of Waynesburg furnace—two miles beyond which it widens out, admitting a wider belt of the slate upon it, which soon divides it into two ridges, the south-eastern ending near the head of Green Briar valley, and the other continuing to the south-west, bordering that valley and Long Hollow to the Juniata. Arriving at the river, this belt crosses and becomes Chesnut ridge, bounding Dry valley on the south-east. It continues thus for fifteen miles to the Three Springs, where it forms a semicircular ridge, sweeping round beyond the end of Jack's mountain to meet another belt, forming Rocky ridge, in Hare's valley.

The south-eastern division of this ridge, with which we started at the turnpike north of Lewistown, passes two hundred yards south-east of Hope furnace and several hundred north of the town of Waynesburg, to the south-west of which it divides, sending one portion to unite with the ridge which ends at the head of Green Briar valley, and the other further to the south-west, to form the general south-eastern boundary of Green Briar valley, and to form a part of the broad table land of sandstone which occupies most of the space between this valley and the Juniata, and which ends near Newton Hamilton.

Another sandstone ridge, the most south-eastern of the series, seen immediately north-west of Lewistown, extends for several miles along the Huntingdon turnpike until it terminates about half a mile north of Strodes' mill. This belt of sandstone, like most others, supports a

narrow strip of F. VIII. along its summit, protected from denudation by occupying the middle of a trough in the strata.

The broad table-land of sandstone already mentioned, sends a narrow ridge or tongue, ending a little west of Newton Hamilton. It also, in consequence of a short anticlinal axis, protrudes another similar promontory across the Juniata, at the dam below that town; while the ridge forming its south-eastern margin, crossing the river a third of a mile below the dam, recrosses it twice more at the bend, and passes it just at the mouth of Aughwick creek, and thence runs to Shirleysburg, flanking Owen's ridge on the north-west.

The short anticlinal axis of Prater's ridge brings up the sandstone south of Newton Hamilton. This belt of the formation crosses the bend of the Juniata, and forms, with the belt just described, a narrow trough, extending between two and three miles south-west, and embracing a little belt of the slates of F. VIII., forming a valley for Aughwick creek.

The south-eastermost belt of sandstone is the ridge bounding Sugar Valley. Commencing opposite Galloway's Gap, it soon includes, like the rest, a narrow zone of the dark slates of F. VIII. lying along the trough in its summit. This zone of F. VIII., becoming thicker towards the south-west, embraces, about three miles from its origin, a highly important band of *iron ore*, opened at Mevey's ore bank. The ridge, and its contained belt of slate, crossing the Juniata north of Bell's mill, presents us with another exposure of the ore at Bell's ore bank. The band of ore follows the slate for some distance towards the south-west, lying now nearly on the crest of Owen's ridge. The belt of slate widening and deepening towards Shirleysburg, the sandstone ridge separates—one part folding over the axis of Owen's ridge to meet the corresponding sandstone beds of its north-western flank, terminates near Shirleysburg; the other running on to the south-west, ends near Orbisonia, by saddling, in like manner, the axis prolonged from Germany valley, and uniting with another belt of sandstone, forming part of Sandy ridge, on the south-east. This last named ridge crosses Black Log creek above Winchester furnace, and continues thence parallel to Black Log mountain, with a uniform north-west dip, for several miles. Near the south-west end of Black Log mountain, it gradually leaves its base—Aughwick creek flowing in the limestone valley between them. The sandstone ridge north-west of Littleton is a continuation of this belt of F. VII., which meets a corresponding belt that ranges along the south-east side of Shade mountain, at a point about a mile and a half south-west of Littleton, where the two-fold together, saddling the anticlinal axis of Black Log valley.

The sandstone F. VII. as developed at the base of *Scrub Ridge*, consists only of a few layers of fine conglomerate and some massive beds of calcareous sandstone, containing the common fossils of the formation. It is in all probability not more than twenty feet thick. It loses itself a few miles north of McConnellsburg, near the commencement of the great dislocation at the foot of Scrub Ridge, and does not emerge again towards the south-west for several miles.

When it does appear it follows closely the range of the underlying limestone before described.

In *Little Cove*, the formation consists of beds of fine conglomerate and of coarse sandstone much impregnated with iron. Between five and six miles south-west of the Mercersburg turnpike, and three miles south-east of Warren Iron works, the sandstone commences in the synclinal axis of the Little Cove. It soon separates into two belts, that on the north-west, forming a considerable ridge running near the side of the Cove, and about three fourths of a mile north-west of the Warren works. The other division ranges along the south-east side of the Cove, forming also a distinct ridge, which passes about the same distance south-east of these works.

The ridges bounding *Pigeon Cove*, are capped by this formation developed in considerable thickness. The rock consists of a fine grained conglomerate and a coarse brownish-yellow sandstone, having the usual appearance and the characteristic fossils of F. VII.

Iron Ores of F. VII.

Near Chester Furnace in Huntingdon county, there is a valuable deposit of cellular brown iron ore in the belt of F. VII., which composes Chesnut Ridge. The sandstone here consists of two members, the upper a soft coarse grained sandstone, the lower a buff coloured, fine grained and very argillaceous sandstone, remarkable for its square cleavage. Precisely at the junction of these two strata, occurs the ore in a bed usually about two feet thick. It is generally more or less sandy and what is even more detrimental, contains frequently a large amount of *oxide of manganese*. It seems to be derived from the filtration through the upper porous and ferruginous sandstone carrying down the oxide of iron to the top of the less penetrable argillaceous bed beneath. This ore has been dug at several places, but the efforts hitherto made to smelt it have proved unavailing in consequence of its extreme impurity.

Formation VIII. Dark Olive Slates.

In the belt of country before us, the lower layers of F. VII. consist for the first thirty feet or thereabouts of a very dark slate. Above these occur the calcareous beds called by us the *cement layers*, from containing occasionally a good *hydraulic cement*. These are generally but a few yards thick. Over them, varying a little as to their precise position, are bands of an impure *carbonate of iron*, which when unaffected by the action of the atmosphere is of a bluish-grey or lead color. These support a thick mass of black slate upon which repose in turn the grey sandstone and olive slate, distinctive of the middle divisions of the formation. Higher in the series are buff, olive, and sometimes pinkish slates, generally very soft and friable.

In the greater number of the synclinal ridges of the sandstone, a

narrow trough running centrally along the summit, contains only the black slate at the very base of F. VIII.

In the ridges of a different structure this black slate occupies a narrow valley with the coarse sandstone of F. VII. on one side, and hills of the grey sandstone, and olive slate on the other. The hills of the upper part of the formation are more rounded. These features in the topography are thus specified, as affording an important clue to the range of the iron ore above described, which seems to be a continuous bed, following the calcareous layers of the lower part of the formation, sometimes for a mile. From the general steepness of the dip in the several belts of the sandstone F. VII. and from its trivial thickness, these valuable lower layers of the overlying stratum F. VIII. have been effectually protected from denudation along the troughs or synclinal axes, affording a beautiful provision for the protection and distribution of the iron ore.

In tracing the narrow ridges of the sandstone, I took occasion to mention these included belts of the lower layers of the overlying slate: it is needless therefore to describe again their range. I shall therefore, mention only those belts in which the important ore accompanying them is worked.

The ore bank one mile north of Atkinson's mill, wrought by Mr. Patton, for the supply of Hope furnace, is situated in this formation. The belt here is that of the second sandstone ridge, south of Jack's mountain, lying between the first and second mentioned axes.

The ore dug a little west of Waynesburg furnace, occurs in the belt between the second and third anticlinal axes.

The ore diggings of Chester furnace, belong to the lower layers of F. VIII., cropping out on the north-west side of the wide basin of great Aughwick valley, a continuation of that of Green Briar valley.

Mevey's and Bell's ore banks already mentioned, occur in the synclinal axis between the sixth anticlinal axis and Blue Ridge, in the corresponding belt of F. VIII. on the summit of the sandstone ridge.

Morrison's ore bank is on the outcrop of the same lower layers of the slate on the south-east side of the synclinal axis, between Prater's Ridge and Chesnut Ridge.

The ore banks of F. VIII., near Orbisonia, are in the same synclinal axis, which is continued from the middle of Negro valley.

The precise geological situation of this valuable and most extensive band of ore is here given, in the hope that individuals interested in the subject, may by attending carefully to our descriptions of the formations in their several complicated belts, and by taking as a guide the various anticlinal axes or lines of elevation, and synclinal axes, or lines of depression, trace for themselves the course which it takes along the hills. The discovery in the prosecution of our researches of the continuous nature of this ore in the lower layers of F. VIII., and of the no less valuable bed of fossiliferous ore peculiar to F. V. furnishes just cause of satisfaction to those engaged in the geological survey.

Green Briar Valley.

Formation VIII, with gently dipping strata, commences at the north-east end of this basin, two miles from Waynesburg, where two narrow belts which previously occupy the summit of the third and fourth sandstone ridges, counting from Jack's mountain, coalesce by the dying out of the anticlinal axis of the limestone valley of Waynesburg furnace. This valley is widest opposite Glasgow's mill, on Beaver run, being there about a mile and a half from south-east to north-west.

South-west of Newton Hamilton, where the fifth anticlinal axis with its ridge of sandstone ends, it merges into another broad belt of F. VIII. lying north of Prater's Ridge, the united tracts of the olive slate being here two miles in breadth. Prater's Ridge uplifted by an anticlinal axis separates this broad belt for a space into two, forming a narrow one between it and Owen's Ridge, and leaving the principal portion of the formation on its north-west, spreading across the whole of the great Aughwick valley to the base of Chesnut Ridge. The belt then continues to the south-west, bounded by Chesnut Ridge and Owen's Ridge, the latter ending at Shirleysburg. Here the main basin of F. VIII. is about two miles wide. Beyond the end of Owen's ridge, its boundary on the south-east, is the ridge of sandstone which terminates at Orbisonia. At Shirleysburg, the main belt is joined by a narrow one, the same which contains Mevey's and Bell's ore banks, coming from the Juniata and opening here into the general basin. In like manner another narrow tongue of F. VIII. commencing on the summit of Sandy Ridge, a short distance from its north-east extremity near Germany valley, expands by a division of this ridge and merges itself into the general body of the formation at Orbisonia, beyond which to the south-west, the main basin of F. VIII. containing but one central synclinal axis, is bounded on the south-east, by the sandstone ridge which follows the foot of Black Log mountain, and on the north-west, by that which ranges near the base of Jack's mountain. In this part of its course it is two and a half miles wide, its surface diversified with rounded swelling hills of the slate.

About three miles west of Orbisonia, and a little beyond the junction of Three Spring creek and Aughwick creek, an extensive belt of the thick overlying stratum F. IX., commences in a ridge occupying the synclinal axis in the centre of the basin. This tract of red argillaceous sandstone divides the olive slate formation into two ranges, that on the north-west running on and meeting the slate belt which traverses Hare's valley, these saddling at their junction the anticlinal axis prolonged from Jack's mountain. Where this occurs, the belt is three miles in width, being bounded on the north-west by Clear ridge. Rapidly contracting, it forms a triangular area terminating in a point eight miles south-west of Jack's mountain, when it is overlaid by the red rocks of F. IX.

The other zone of olive slate lying between the sandstone ridge at the base of Black Log mountain and the margin of the red sandstone on the north-west, runs towards the south-west, between ten and eleven miles, meeting a belt of the same formation sweeping round from the south-east side of Black Log valley, at the base of Shade mountain, at a point two miles south-west from Fort Littleton. Opposite Littleton, the belt forms a basin of simple synclinal structure, lying between the antilinal axis of Black Log valley, and the M'Connellsburg Cove. On the north-west side the strata have a gentle dip to the south-east, but adjacent to Scrub ridge, they are perpendicular, being affected by the dislocation.

About three miles south-west of Littleton, another tract of F. IX., commences, dividing this part of the olive slates into two ranges, one stretching along the base of Scrub ridge, and the other uniting with the belt north-west of Littleton, by saddling the axis of Black Log mountain three miles from its termination. The wide belt thus composed sweeps westward to occupy the centre of the valley between Sideling Hill and Big Scrub ridge, continuing as one belt two and a half miles in width, for sixteen miles, to the north-east extremity of Pigeon Cove. Here the lower formations being protruded, it separates, one division running north-west of the Cove, the other south-east, until they both reach the Potomae.

The *Scrub Ridge* belt is *overtilted* or *inverted*, the strata dipping eighty degrees to the south-east. A considerable portion of the formation is buried under the dislocation. Opposite to M'Connellsburg, it is four hundred yards in breadth. Further west where Scrub ridge itself ceases, the hills of this formation bound the Cove. It emerges to the surface again near Hunter's mill, and at Hanover furnace, the entire formation is once more developed though its beds are still perpendicular. In this attitude it crosses into Maryland.

Little Cove, contains in the middle of its basin a broad belt of F. VIII., having a width of a mile and a half where it is intersected by the State line. Gradually contracting towards the north-east, it terminates in a point a little more than three miles north-east of Warren Iron works. The strata on the north-west side of the synclinal axis dip gently towards the south-east, while those on the south-east side are perpendicular. Warren Iron works are situated near the centre of the belt.

Iron Ore in F. VIII.

The discovery of the true nature and exact position of the iron ore connected with this formation, furnishes an interesting illustration of the utility of geological researches systematically prosecuted. The ore having been previously dug at the out crop, only at remote and scattered points, no general clue to its position applicable in practice had been detected, nor was it probable that any could be, until the order of superposition had been minutely and methodically studied. No sooner was this done however, than we perceived that all the

outcrops of the ore accidentally discovered in the formation, belonged to one solid and extensive band regularly interstratified in the lower part of these slates; accompanied by such well marked features in the adjoining rocks as to render the tracing of its course with proper skill and knowledge, a matter of ease and certainty. From the descriptions above given of the several belts of F. VIII. in the long and wide valley of Lewistown, some idea can be had of the truly prodigious body of this ore which remains yet undeveloped. I cannot hope however, to convey to persons not thoroughly familiar with the intricate topography of the region, a correct conception of the range and distribution of that part of F. VIII, in which this ore should be sought until I am enabled to elucidate my descriptions by the requisite maps and sections.

The stratum of ore varies in thickness from three or four feet, to ten or fifteen feet, and lies usually closely contiguous to the calcareous or cement layers of the formation, overlying them only a few feet and being removed from the upper surface of the fossiliferous sandstone F. VII. by from fifty to one hundred feet of strata. Whether it is evenly spread as one continuous deposit from Lewistown to Maryland, or whether it is less constant, thinning away and re-appearing, cannot be determined until its several belts are more explored by those interested in using it. The stratum remote from its outcrop, consists of bands of ponderous bluish grey or lead colored *proto carbonate of iron* sometimes breaking into square masses, and sometimes of a more slaty or laminated structure. It does not effervesce when touched with acid; when roasted it becomes reddish brown and is then strongly attracted by the magnet. The analysis in chapter VI. will display the usual composition of the ore.

It is only where the stratum has been long exposed at its outcrop to atmospheric influence, converting it into the brown *per-oxide of iron*, by which it assumes a wholly different aspect, that it forms the deposit at present worked by the furnaces situated near it. This ore, at its outcrop, is of a dark hazel brown color, a smooth grain, and a cellular structure. That which is derived from the rectangularly cleaving portion of the solid bed, is in square masses, with large squarish cells, often glazed and iridescent on their inner surface, and either entirely empty or partially filled with a pure bluish clay. Sometimes where the bed has been so protected as to escape extensive atmospheric action, this conversion to the brown *per-oxide* is only partial, a solid nucleus of the bluish *proto-carbonate* forming the interior of the lump, while the *per-oxide* occurs only on the surface, in the form of a crust of greater or less thickness. Between this crust and the undecomposed nucleus, the earthy particles, originally in that portion of the *proto-carbonate* which has been converted into the *per-oxide*, having been left by the iron in assuming its new state of concretion, lie loose in the intervening space, forming a dust when dry, and when moist a tenacious clay. This travelling of the atoms of *oxide of iron* from the interior to the circumference of

the mass, in all cases where a *proto-carbonate of iron* undergoes conversion to the *per-oxide*, is a highly curious fact which science has not yet explained.

Distribution of the Ore.

It is probable that this bed of ore extends, either partially or uninterruptedly, for considerable distances in nearly all the synclinal axes where the lower beds of F. VIII. occupy the summits of the sandstone ridges between Lewistown and Shirleysburg. The ore banks at present worked are in these positions. The ore occurs in Little Cove, and at Pennock's furnace in Huntingdon county, in precisely the same geological relations; but to what extent it prevails throughout the long line of intermediate country, nearly thirty-five miles in length, we have at present no means of ascertaining.

Strata of very analogous ore exist on the flank of Dickey's mountain, near Hanover furnace, and, we have reason to believe, range very extensively in this part of the series. Ore of the same cellular structure as that above described, is visible in a similar position on the flanks of Cove mountain, and on the north flank of Stone mountain. Its place in the strata is a short distance above the thick mass of red shale in the upper half of F. V. It is not to be confounded with the fossiliferous ore, already mentioned, which occupies a lower position, being among the calcareous shales nearer the middle of the stratum.

Iron Ore of F. IV. on Black Log Mountain.

There is a deposit of stalactitic iron ore occurring in a transverse fissure near the crest of Black Log mountain, four miles south-west of Rockhill furnace. The adjoining rock is the upper white sandstone of F. IV. The ore is of a brownish black colour, and of a cellular and stalactitic structure. It is rich, easily reduced, and produces a red-short iron. The rocks of F. IV. here are reddish, being tinged with oxide of iron, the solution of which is probably the source of the deposit.

FORMATION IX.—Red Shales and Sandstones.

At the passage of the underlying olive slates of F. VIII. into the red rock of F. IX. above, we meet with a thick series of beds, composed alternately of the materials of the two adjacent strata. They consist of buff and olive coloured slates, interstratified with reddish slates of very similar composition. They are highly argillaceous but compact, and offer considerable resistance to denudation. They usually form rounded but continuous ridges, more elevated than the neighboring hills of the olive slate, and give rise to a soil which is well adapted to cultivation. Clear ridge in Hare's valley, and Timber ridge on the north-west side of Licking creek, consist of these beds.

Formation IX. commencing over the synclinal axis in the middle of the basin of Great Aughwick valley, near the mouth of Three Spring creek, gradually expands in its course towards the south-west until about eleven miles from its origin it meets the other belt which ranges along Hare's valley, and follows the base and flank of Sideling hill. The two compose then a track several miles broad, in which the anticlinal axis of Jack's mountain gradually flattens down or expires. The strata now gradually assumes throughout, a north-west dip, when the belt contracts and ranges thence, with great regularity, to the south-west, along the base and slope of Sideling hill, until it reaches the Potomac. The sudden narrowing of the belt occurs opposite to a curvature in the anticlinal axis which extends from Black Log valley into Pigeon cove; but the cause of this curvature, and of the diminished breadth of F. IX., is manifestly the sudden subsidence of the Jack's mountain axis of elevation.

Another considerable belt of F. IX., occupies the principal part of Big Scrub ridge, where it supports, in the form of a basin resting on an elevated table land, the overlying grey sandstone of F. X. and the still superior red shales of F. XI. Commencing north of Harshy's mill, in the synclinal axis north-west of Little Scrub ridge, this tract of red rocks of F. IX. immediately widens out, and four or five miles to the south-west embraces the table land of overlaying rocks referred to, which divides it into two nearly parallel zones. That on the north-west, forming part of the Licking creek settlement, exhibits the strata at the base and on the north-west flank of Big Scrub ridge dipping thirty degrees to the south-east. The other belt follows the south-east base and flank of the ridge, and has its strata in an almost perpendicular altitude, uptilted by the prodigious pressure exerted along the great dislocation in the formation at the base of Little Scrub ridge. Between six and seven miles from their point of separation, these two belts of F. IX. reunite, the upper harder beds of the stratum forming the summit of Big Scrub ridge for several miles further to the south-west, beyond the termination of the sandstones of F. X.—The whole belt of F. IX., about two miles in width, continues towards the south-west until it reaches the Potomac several miles below Hancock—its beds on the south-east dipping steeply north-west, and those on the opposite side gently towards the south-east.

FORMATION X.—*Coarse Grey Sandstone and Conglomerate.*

This rock, besides forming the summit of Sideling hill throughout its entire length from Terrace mountain at the Juniata to the Potomac, forms the table land of all the central portion of Big Scrub ridge. In this latter mountain, it contains a synclinal axis, and forms, therefore, a trough or basin, which is about six miles long and one wide. Within this basin is a rather curious elevated little valley, the surface of which is about three hundred feet below the crest of the sandstone ridge which every where surrounds it. From the outer base to its summit, Big Scrub ridge is about eight hundred feet high. The

beds of conglomerate have a perpendicular dip on the south-east side, and on the north-west a gentle inclination of thirty degrees to the south-east. The little synclinal valley, covered by an extensive meadow, is drained by a defile or gorge in the perpendicular wall on the south-east, where the stream called Tumbling run finds its course impeded by a succession of waterfalls.

FORMATION XI.—*Red Shale.*

The small valley on the top of Big Scrub ridge is formed by a belt of F. XI., about five miles in length and six hundred yards in breadth, encircled by a perpendicular strata on the east, and more gently sloping ones on the west. This tract is called the "meadow grounds," and is resorted to, at proper seasons, as a natural pasture for cattle.

The broad valley lying south-east of Sideling hill, from the general poverty of the soils of F. S. VIII. and IX., is a sterile district, thinly settled. Its physical features are those of a rolling, hilly surface.

Iron Ore near the contact of F. IX. and F. X.

Rather more than two miles from the north-east extremity of Big Scrub ridge, a small deposit of iron ore occurs on the north-west flank of the mountain. It is associated with the sandstone which lies but a short distance below the conglomerate belt of F. X., and which form a range of cliffs along all this side of the ridge. Though not abundant, the ore is interesting from its beautiful structure. It is a fibrous, radiated hematite, arranged in parallel cylinders or stalactitic rods. These cylinders seem all to have been pendent, like icicles. It lies loose at the base of a precipice of the argillaceous sandstone, having apparently fallen out of a cleft or fissure in the stratum.

M'Connelsburg Cove.

This is a little valley of elevation, consisting, in its centre, of F. II., the great limestone formation near the base of our lower secondary series. It is bounded on the south-east by the main Cove mountain, and on the north-west by the Scrub ridges. Nearly opposite M'Connelsburg, Little Scrub ridge, extending from the Burnt Cabins, ends; and six miles to the S. S. W., near Hunter's mill, another ridge, called Diekey's mountain, rises to occupy the same range. These two ridges are prolongations of the same belt of the white sandstone F. IV. which between them has been heaved down to a great depth by an enormous dislocation which extends for at least twelve miles along the north-west side of the cove, burying the strata which ought naturally to occupy the surface under more than two thousand feet of other rocks inverted over them, and bringing, in one place, Fs. II. and VIII. violently into contact.

Limestone F. II. and its Anticlinal Axis.

The limestone of the cove consists of alternating beds of pure blue and siliceous limestones, and whitish magnesian limestones adapted for making *hydraulic cement*. The upper layers, adjoining the overlying slate, embrace dark calcareous slates and black limestones, but without that profusion of fossils which these layers contain where they are exposed in some of the limestone vallies to the north and north-west.

The limestone is traversed by an axis of elevation which ranges somewhat centrally along the valley, and passes directly through M'Connellsburg. Its regularity is somewhat disturbed by the contiguity of the great fault or dislocation on the north-west.

Dislocation along the side of the Cove.

The rocks composing Little Scrub ridge, and ranging along both sides of it, are, for the first five or six miles of its course from the north-east, in their proper relative positions, though slightly overturned or inverted as far to the south-east as the position of the anticlinal axis. Such is the state of things at Harshy's gap. About two miles further to the S. S. W., or seven miles from the Burnt Cabins, the great fault commences, running parallel with the ridge. The adjoining limestone on the north-west side of the cove begins to assume its natural dip towards the north-west, becoming less inclined as we trace it to the S. S. W. Presently, however, the slate F. III. disappears—then F. IV. the sandstone constituting Scrub ridge, dipping now eighty degrees to the south-east. Here all the upper portions of F. V., the limestone F. VI., the sandstone F. VII., and a large part of the slate F. VIII., all vanish—the rest of F. VIII. dipping, like the sandstone F. IV. in contact with it, eighty degrees to the south-east. The strata F. S. II., III., IV., V., VI., VII., and VIII., have all been broken off and heaved down on the north-west side of the fracture, leaving only a wedge-shaped mass of F. IV. composing the remnant of Little Scrub ridge, filling the fissure between F. II. and F. VIII. This unconformable fragment of F. IV. is much shivered and polished by the enormous crushing force to which it has been subjected.

About three miles further to the south-west, opposite to M'Connellsburg, the same condition of things still exist, only the limestone F. II. dips more gently to the north-west, and a larger portion of F. VIII. has been cut off by the fault. Little Scrub ridge ending at this place, the limestone F. II. abuts directly against the slate F. VIII., the latter bounding, in reality, the cove, though the mountain a mile to the north-west, called Big Scrub ridge, already described, is generally considered as the boundary. Tracing the fault for several miles to the south-west, the limestone in contact with it becomes less inclined to the north-west, while the remnant of F. IV. occupies the fissure at intervals, forming at several places a low and obscure

ridge. At Rankin's clover mill, four miles to the south-west, at the termination of Little Scrub ridge, the limestone adjacent to the fault dips to the opposite quarter, or the south-east. From this point two miles south-west, to Hunter's mill, situated immediately on the fault, the same state of things prevails, F. VIII. beginning to emerge. A little south-west of Hunter's mill, the sandstone E. IV. rises into Lowrey's knob, and continues thence to the south-west in a ridge, called Dickey's mountain—the other formations emerging on the western flank of Lowrey's knob. Here Es. V., VI. and VII. appear in a perpendicular attitude; and along the south-east side of the knob lies a portion of the slate F. III., with its beds in great confusion. At *this* point is a rich and valuable deposit of *iron ore*, attached to Hanover furnace.

The ore lies in the clayey soil over the crushed slate, and seems to have been collected here from the filtration of the ferruginous matter out of the sandstone of the knob which rises close at hand in a steep slope. Opposite to the knob the anticlinal axis of the middle of the Cove disappears being obliterated by the upheaving of that part of the limestone which lies south-east of the fault. Farther towards the southwest, the dislocation becomes itself an anticlinal axis, the same which elevates the strata in the south-west end of the Cove. In this part of the Cove, the rocks on the north-west side of the axis are perpendicular while those on the south-east side incline gently towards the base of the Cove mountain. The limestone beyond this is overlaid across the axis by slate which forms the head of the valley towards the south-west, which is soon after closed by the union of the Cove and Dickey's mountains.

F. III. Slate.

The slate F. III., is a stratum of considerable thickness in the Cove, covering the north-east end of the valley for several miles, the belt dividing where the limestone is protruded to the surface. The western belt keeps along the base of Little Scrub ridge until it is lost in the fault. The eastern one bordering the Cove on the flank and at the base of Cove mountain is nearly half a mile in breadth. It dips uniformly to the E. S. E. thirty degrees, and ranging southward meets the western belt which emerges from the dislocation near Hunter's mill, and ranges about three and a half miles to their junction. After their union, the general belt of slate covers the southern end of the valley called the *corner* of the Cove, for three miles. In consequence of the profusion of the debris from the adjoining sandstone mountain, which here forms the soil, this part of the valley, is almost incapable of cultivation.

Iron Ore of F. III.

The ore bank of the Hanover furnace occurs on the south-east side of Lowry's knob, just where the slate F. III. emerges from the

Scrub ridge fault. The slate is much contorted, and crushed in places into a clay into which the ore has been lodged. At the outcrop the ore formed a thin waving layer which traced into the side of the hill assumed a perpendicular direction and became much thicker. It lies surrounded by clay, that beneath it being very unctious and beautifully colored. The ore is much used. It occurs often in angular masses of considerable size, having a fracture or cleavage similar to that of the adjacent clay. It is compact and ponderous, has a dark reddish brown color, and is as rich as the *hydrated brown ores* generally are, which are derived from this formation. Its aspect and composition are however somewhat variable. Smelted with the cold blast it makes a good malleable iron a little *red short*, or not welding with facility at a red heat. The analysis in chapter VI. will display the average composition of this interesting ore.

The clay underlying it is different from that above it, being almost impermeable to water, and hence the effectual manner in which it has arrested the *oxide of iron* percolating from above.

Formation IV. White Sandstone.

In the Cove mountain and neighbouring ridges, F. IV. does not retain the tripple subdivision to the extent which it exhibits in the mountains further to the north and north-west, and hence we do not find its ridges here, possessing the double summits which characterize those of other districts.

Little Scrub Ridge, commencing in Sidney's knob at the Burnt Cabins, is there of the usual elevation of the mountains of F. IV., but advancing towards the south it declines in height and assumes an undulating summit. This is in part owing to the increasing steepness of the strata. The belt ends as before described by disappearing in the fault opposite M'Connelsburg, and appears only at intervals in three or four places for six miles to the south, lying as a detached mass in the fault. Reaching the surface again in Sidney's knob, the sandstone soon swells into a mountain of considerable height, which reaching the Maryland line sweeps eastward and terminates in the end of Cove mountain.

The Cove Mountain, commencing at Sidney's knob, bounds the eastern side of the Cove, and runs in a nearly straight line south, until opposite M'Connelsburg, embracing between it and the southern continuation of the Tuscarora mountain a narrow trough or synclinal axis which there closes up. Beyond the junction, the mountain sweeps to the south-east, the Chambersburg turnpike ascending its flank. By the curve in the mountain, the Cove is considerably widened. Near the curve terminates the anticlinal axis of the Tuscarora mountain. The Cove mountain now assumes its proper direction to the S. S. W., and gently curving south and then westward finally unites with Dickey's mountain not far from the State line. Its rocks dip uniformly towards the E. S. E. thirty degrees.

About two miles north of Loudon, a synclinal axis or trough originates on the eastern side of the Cove mountain in F. IV. Expanding towards the south, this trough becomes the basin called the Little Cove, the western ridge of which runs south, as the prolongation of the Tuscarora and Big Cove mountain, and the other running S. S. W., becomes the Little Cove mountain, bounding the valley west of Mercersburg. The formations together with their ores which compose the Little Cove basin have been already described with sufficient fulness for the present

SECTION III.

Kishicoquillas Valley.

Kishicoquillas valley, the next belt of country towards the north-west, beyond the Lewistown valley, extends through parts of Mifflin and Huntingdon counties, from north-east to south-west, having a length of nearly thirty miles, and a breadth varying from two to four miles. Nearly the whole area of the valley consists of fertile land, some of which is under high cultivation. It is a beautiful instance on a large scale of what is termed in geological language a *valley of elevation*. The bed of the valley consists of Fs. II., and III., uplifted to the surface by several anticlinal axes and the whole bounded by mountain ridges composed of the less destructible sandstones of F. IV. The surface of the valley in its highest portion around Allenville, is elevated three hundred and fifty feet above the Juniata, at Lewistown. It descends gently in all directions from this central district. Two deep gorges or gaps in the belt of mountains which encircle it, admit us into this valley. One of these called Brown's Gap, is in Jack's mountain, its general south-eastern boundary. Through this passes Kishicoquillas creek. The other Gap is in Stone mountain, which encompasses the valley on the north-west. This is at its eastern extremity, and affords an outlet for Goslin run. The two mountains which confine the valley are *Monoclinal Ridges*, that is to say their strata dip in but one direction, those in Jack's mountain dipping to the south-east, and those in the Stone mountain to the north-west. After ranging for many miles to the south-west, and gradually converging, these mountains fold together over the anticlinal axis of the valley, and thus shut it up. The anticlinal axis then ranges along the summit of Jack's mountain to its termination near the Three Springs in Huntingdon county.

Limestone F. II.

The lowest strata of the great limestone formation which have been brought into view near the centre of the valley, by uplifting agencies, consist of blue limestones, some pure and some siliceous, alternating with lighter coloured greyish-blue magnesian limestones, nearly of the composition called dolomite. A little higher in the

formation, these magnesian beds constitute a thick belt; while above them, bluer and more purely calcareous limestones succeed, supporting, in their turn, a mass of dark argillaceous limestones and nearly black calcareous slates, the latter often highly fossiliferous. These upper layers mark the passage of the limestone into the overlying slates of F. III.

Slate F. III.

The slate F. III. encircling Kishicoquillas valley ranges in two belts. That on the south-east follows the base and slope of Jack's mountain, spreading usually from the ridge a few hundred yards into the valley and rising more than half way up the acclivity. The other belt, on the north-west, leaving the subordinate vallies between the knobs at the north-east end of the principal valley, ranges along the base of the Seven mountains, and then along that of Stone mountain, until it meets the other belt connected with Jack's mountain, when the two occupy the south-west end of the valley for more than a mile. The slate again shows itself on the Juniata, at Drake's Narrows, four miles beyond, having passed out of Kishicoquillas valley under the axis of the mountain. Opposite Greenwood, the slate expands further into the valley, in consequence of a dislocation of the strata in Stone mountain. This part of the belt, several miles in length, is three-fourths of a mile broad. Further to the south-west, it resumes its usual position near the base of the ridge, but extends high up its slope owing to the gentleness of the dip. Still further to the south-west, it becomes perpendicular; and about seven miles beyond Allenville, joins the south-eastern belt over the anticlinal axis.

At its north-eastern extremity, Kishicoquillas valley is subdivided into three lesser vallies, by the commencement of two synclinal ridges, locally called knobs. One of these little vallies destitute I believe of a name, lies between the Seven mountains and Baird's knob, and is prolonged to the north-east between the former range and Stewart's knob. The central one lies between Beattie's and Stewart's knobs, and is called Orr's valley. The third or most south-eastern is included between the southern or Beattie's knob and Jack's mountain. These conspicuous knobs are high ridges of regular synclinal structure, appearing, when seen from a distance, to consist each of a high central ridge and two outer ones in the form of broad and very regular terraces. The northern knob, called Stewart's, is on the same range with Baird's knob, the two occupying one synclinal axis.

The limestone ceases about one hundred yards south-east of Greer's tavern, and about five hundred yards from the base of Jack's mountain. Its north-western margin is near the furnace and a little south-east of Thompson's tavern. The formation extends to the north-east a short distance beyond Sterrett's mill, where the upper or fossiliferous layers show themselves. The limestone itself is not developed in the small valley between Jack's mountain and Stewart's

knob. It sweeps round Beattie's knob, and in a rather narrow belt ascends Orr's valley to within one mile of Mr. Solomon Close's, the last farm house between the knobs. It does not pass round Stewart's knob, as the synclinal axis of that knob carries a trough of slate throughout the whole distance between it and Baird's knob, south-west of the turnpike. The only part of F. II. developed in the valley to the north-west of this synclinal axis, is the fossiliferous portion, consisting of the uppermost layers which are well exposed on Mrs. Christman's farm.

Anticlinal Axes of the Valley.

The axes which have protruded the limestone to the surface, are not of that symmetrical structure found in valleys of elevation of a simpler form; for instead of the strata dipping in both directions away from the central line, the two sets of dips are often towards the same quarter, those on one side of the axis being *inverted*. This inversion occurs almost in every instance on the north-west side of the anticlinal axes. Even when a part of the strata have not been averted near an anticlinal axis, those on the N. W. exhibit with a few exceptions, a steeper dip than those on the S. E. These striking features point to something very peculiar in the mode in which our rocks have been elevated by subterranean forces and seem plainly to indicate that the uplifting pressure was not strictly vertical, but exerted, from the N. E. toward the S. W. The probable cause of this will be discussed in my final report.

An anticlinal axis traverses the little valley between Jack's mountain and Beattie's knob. It dies out between four and five miles north-east of the turnpike. Another anticlinal axis follows near the middle of Orr's valley between the two knobs, being visible on the main road leading up this valley, as far as the uppermost *sink hole*. This axis is prolonged to the southwest, passing, apparently one-third of a mile south-east of Perryville. A third anticlinal axis ranges immediately to the north-west of the last and parallel with it, running also to the mouth of Orr's valley or to the south-east of Stewart's knob. The rocks on the north-west side of this axis show an inverted dip or incline to the south-east. This is clearly seen on a farm half a mile east of Perryville, where the beds on the south-east side of the axis incline thirty degrees to the south-east; and those on the north-west, seventy-five degrees to the south-east. The very line of the axis is discernable in a broad *sink hole* immediately north of M'Dowell's house. It probably dies out in Orr's valley about one mile above its mouth. This last axis, extending along the north-west side of the general valley near the base of Stone mountain, terminates a short distance south-west of Sinkey's gap.

On the south-east side of the valley, another more extensive line of elevation in the limestone commencing three miles south-west of Brown's Gap, and extending to the south-west, becomes the main central anticlinal axis of the valley, and afterwards of Jack's

mountain in Huntingdon county. The ends of this axis and that before described as lying near the base of Jack's mountain pass each other, the overlapping extremities being nearly two miles apart. Between these extremities terminate the two other axes first described, that of the Little valley south-east of Beattie's knob, and the south-eastern or longer one, of Orr's valley. The anticlinal axis nearest to Stone mountain, has its strata on the north-west, overturned as already mentioned. The main axis nearest to Jack's mountain extends for many miles parallel to its base from which it is about a mile distant. To the south-east, of Greenwood, it exactly coincides with the line of valuable *ore banks*, and at Allenville shows itself about midway between the town and the foot of Jack's mountain. It ranges regularly on towards the S. W. between four and five miles, preserving a uniform and moderate inclination in the strata on both sides of it until the gradual bending round of Stone Mountain brings it against its base. Here it assumes a sudden change of direction, carving towards the S. S. W. to run parallel with the foot of that ridge. The rocks on the N. W. side of the axis previously at a gentle dip, now become perpendicular, and continue thus to the termination of the valley, when it passes under the summit of a broad and lofty ridge formed by the union of Jack's and Stone Mountains.

Iron ore of Kishicoquillas Valley.

The iron ore of this valley is the usual cellular and stalactitic brown ore of the limestone districts. It occurs in irregular nests and layers in the ferruginous loam and clay overlying the limestone to which it seems to bear no fixed relation. Its discovery is therefore a matter almost entirely empirical. In Kishicoquillas valley, however, its distribution is so dependant on the geological structure of the belt, that its range already ascertained by excavations, can be laid down with great precision. All the ore deposits hitherto wrought *occupy the lines of elevation* of the limestones, occupying exactly in the fissure formed by the angular bending of the strata, over the anticlinal axes. It seems probable that no valuable body of ore has been deposited in any other position in the valley. Immediately upon the anticlinal axis which comes out of Orr's valley, and becomes the second one south-east of the foot of Stone mountain, there is a considerable deposit of *iron ore* wrought at Davis's bank. But it is in the fissure of the main axis or that nearest Jack's mountain, that the best ore deposits lie. A little south-east of Greenwood, there is a line of excavations from which large bodies of ore have been taken. The principle banks are those of Messrs. Holliday, Hall and Rawle, and Patton & Co. Little doubt can be entertained that ore of the same quality exists at various other points on the line of the anticlinal axis, both north-east and south-west of these openings. Promising indications of the ore were witnessed on several farms precisely in the range, as ascertained from other independent proofs, of the fissure along the line of the axis.

The evidence of the existence of ore in sufficient quantity towards

the north-east end of the valley are by no means obvious, only a single bank being extensively wrought. This lies about four miles from Perryville, on the farm, I believe, of Mr. Samuel M'Nitt. Its position is upon the crushed anticlinal axis already described, as terminating near the mouth of Orr's valley. This ore is no longer used, owing to too large a quantity of *sulphuret of iron*, which is intermixed with it. I conceive that though the promise of ore in this section of the valley is not inviting, the best chance of obtaining it, is in the line of country immediately contiguous to the range of the crushed anticlinal axis which extends from M'Nitt's to Perryville.

FORMATION IV.—*White Sandstone.*

This stratum retains its triple character in the mountains bounding Kishicoquillas valley, though less distinctly than in the ridges further towards the north-west. The softer and more argillaceous nature of the middle member of formation has given rise by denudation to a bench or elevated terrace on the flanks, not only of Jack's and Stone mountains, but also of the knobs. This has been erroneously conceived by some to mark the shores of a supposed lake, of the existence of which we have no evidence whatever.

Stone mountain, has a sharp narrow and regular crest throughout the greater part of its length. A notch, or depression in the ridge between three and four miles south-west of Milligan's knob, is called Sinkey's gap. The terrace on the side of the mountain from this gap for several miles to the south-west, is about a fourth of a mile wide, and is trenched by a number of deep ravines on the flank of the mountain. It becomes wider near a great fracture in the chain opposite to Greenwood. This fracture or fault occurs where the road leads across from Greenwood into Stone valley. The main crest of the mountain consisting of the upper member or white sandstone of F. IV. suddenly ends, and another ridge, the crest of which is formed by the same upper sandstone, dipping in the same direction, steeply to the north-west, commences northwest of the former at Greenwood furnace. This latter mountain continues south-west as the main Stone mountain, its terrace soon becoming regular and nearly a third of a mile wide. The two crests of the dislocated ridge pass each other, overlapping nearly a mile and a half. The line of dislocation intersects the mountain obliquely, having a N. N. E. and S. S. W. direction, and the rocks to the north-west of it have been heaved up past those on the south-east, so as to dip in the same direction—it is only towards the south-western end of the fault, that the strata on the south-east side dip away from the dislocation. Beyond Allenville to the south-west, the terrace on the flank of the mountain becomes three-fourths of a mile broad. The Rocks of the Lower sandstone division F. IV. form the brow of the shelf, with a less steep inclination than those of the upper division in the crest of the ridge. Still further to the south-west towards the termination of the valley, the rocks becoming more perpendicular, this terrace grows proportionately narrower, and is at last hardly perceptible.

Jack's mountain, bounding the valley on the south-east side displays great regularity in its contour. Its crest or summit is nearly straight, consisting like that of the Stone mountain, of the upper hard sandstone of F. IV. Its strata, generally incline to the south-east, very uniformly at thirty degrees dip. Towards the south-west the mountain gradually sweeps round more to the south, making a convex curve on the side next the valley. Its terrace usually between three hundred and four hundred yards broad, widens near Allenville, and becomes gashed by deep ravines, exhibiting great uniformity of outline, at distances averaging a third of a mile. Beyond the point, where it coalesces with Stone mountain, the ridge assumes the anticlinal structure, though the rocks of the opposite flanks retain nearly their previous dip, that prolonged from Stone mountain, forming the north-west side, being nearly perpendicular; while those continued from Jack's mountain slope to the south-east, at an angle of twenty-two degrees. The broad and majestic ridge thus composed, traverses Huntingdon county, and terminates near the Three Springs, undergoing a gradual flexure to the south as it proceeds.

The next belt of country, proceeding to the north-west, is that of the Seven mountains; but as a general description of this wild unpopulated district, was given in my last annual report, and as a detailed and full account of it can only be rendered intelligible through the assistance of a geological map and sections, I deem it best to postpone publishing the result of our examinations until the appearance of my final report. I shall therefore offer some details, intended to show the resources and structure of Stone valley, and the general belt of formations ranging from the Seven mountains to the south-western side of the Juniata.

Stone Valley.

It will be convenient for the sake of brevity, to extend the name Stone valley to the whole district embraced between Stone or Jack's mountain and Tussey's mountain, as far to the south-west as the Juniata, though that portion which lies between Warrior ridge and Tussey's mountain, is sometimes called the valley of Shavers creek. This subordinate valley, extending to the south-west side of the Juniata, assumes the name of Hartzlog valley, and afterwards, from the knob of Tussey's mountain, five miles from Alexandria, onward to the south-west, it takes that of Woodcock valley.

Confining our attention for the present to the general valley north-east of the Juniata, we may consider it as one broad basin traversed by a principal synclinal axis, extending from the coal basin of Broad Top mountain, through Terrace mountain, and through this valley, and finally through Milligan's knob, and thence by Stewart's knob to the Susquehanna. The slate ridges, which range from the south-west, following, respectively, the bases of Terrace mountain and Siding hill, unite in the central part of what we term Stone valley. Outside of these, Warrior ridge and Rocky ridge, form two belts of the

sandstone F. VII. and unite like the slates, but at a point further to the north-east. Encircling the sandstone of these ridges, are the next lower rocks of F. VI. and F. V., ranging together in a belt along the base of Stone mountain and at the foot of Tussey's. These, by their union, form the head of the valley, F. V., folding over the spurs prolonged from the chain of the Seven mountains.

The only portion of the district, which requires from its intricacy, a minute and detailed investigation, is the belt composing the Warrior ridge and the valley between it and Tussey's mountain. This part is traversed by many parallel and even overlapping axes of elevation. F. V., folded round most of these axes, the *fossiliferous iron ore* is brought to the surface, and therefore much research has been necessary in tracing the exact features of this section of the valley. The general synclinal axis of Stone valley, lies about four and a half miles from the foot of Warrior ridge, and two and a-half from that of Rocky ridge. The inclination of the strata on the two sides of this axis, is nearly equal, being not more than from ten degrees to fifteen degrees. Further to the north west, the dip augments to twenty-five degrees, and again diminishes as we approach Warrior ridge, it being about five degrees where the Juniata intersects the sandstone. On the other side, towards the north-east, it becomes thirty-five degrees as we recede from the middle of the basin to the first hill, parallel to Sideling hill; while in the next belt of slate hills, belonging to F. VIII., the dip to the north-west becomes seventy degrees, and at the Gap in Rocky ridge, the sandstone F. VII., is nearly perpendicular.

The physical features of Warrior ridge, are somewhat peculiar, though its structure is simple and easily explained. Opposite Huntingdon and Petersburg, it is a broad table land, the sandstone F. VII. capping its summit. Along the top of the ridge and in many places at its flanks, it is gashed by deep ravines. The strata are not quite uniform as to dip, undulating gently in consequence of the dying out of some of the axes of the Seven mountains. Towards the north-east, the dip augments, and the ridge accordingly becomes narrower, the sandstone occupying then only the south-east half and the underlying limestone, F. VI., the north-west. Formation VII., curves round to meet the corresponding sandstone of Rocky ridge, about sixteen miles north-east of Huntingdon; from the Juniata, Warrior ridge contracts in breadth also towards the south-west, its strata here being beyond the influence of any axes tending to hold them up in a wide belt.

The several formations, occupying the broad basing before us, are so analogous in aspect and composition to the belts of the same already described in the Lewistown valley, that a passing notice of them in this place will suffice. Formation IX., consists of red sandstone of various shades of colour, alternating with layers of red shale. Formation VIII. embraces much grey sandstone, and towards its upper portion, some beds of a very massive greyish blue variety. These last are quarried near the canal below Huntingdon, and supply an excellent building stone. Beds of superior flag stone occur in the al-

ternation of F. VIII. and F. IX. The general character of F. VII. is that of a white coarse sandstone, which readily disintegrates by exposure. The roads on Warrior ridge are frequently covered with sand to the depth of several inches. The sandstone being intersected by a system of regular and extensive joints in plains nearly perpendicular to the bedding of the rock, and being at the same time thus easily weathered, its blocks sometimes assume singular and grotesque forms, standing forward in crags or rising in remarkable columns. The Pulpit Rocks, near Huntingdon, are an instance of the joint operation of the two causes mentioned.

Some of the beds of this formation, furnish a material admirably fitted for the hearth stones of blast furnaces. The hearth stone of Mill creek furnace is procured from Rocky ridge.

The limestone F. VI. possess very nearly the same features which distinguish it in the Lewistown valley. An ash-colored and very argillaceous variety occurs near its passage into the underlying shales of F. V. This is not adapted either for burning for lime, or for building with. When newly taken from the earth, it has a rather durable aspect, which has occasionally deceived the engineers who have used it in the construction of aqueducts, and other important structures on the canal. It is well exposed three hundred yards below the forge at Petersburg. These alternating rocks between F. V. and F. VI. are very thick, and comprise many of the hills north-west of Warrior's ridge. When tracing the *fossiliferous iron ore* of F. V., I shall allude to the beds of that stratum, more particularly of the portion connected with that valuable layer of *iron ore*. Formation V. occurs in the flank and at the base of Stone mountain, where, however, the ore bearing portion of the rock does not form a distinct ridge. The belt continues for nineteen or twenty miles to the north-east from the Juniata, and then expands from the head of the basin between the Stone and Broad mountains. Ranging north-east of Greenwood furnace, it folds round the end of Broad mountain, taking an anticlinal form which throws up the ore in a chain of elliptical hills, where it is dug at the ore banks of Messrs. Alexander and Diarmid. In this manner it winds round the end of all the ridges of F. IV. between Broad mountain and Tussey's mountain, making its south east boundary the north-west base of Warrior ridge, and then occupies the valley of Shaver's creek, and its continuation to the north-east, ranging also to the south-west into Hartzlog and Woodcock vallies. This wide belt embraces many anticlinal axes, between which lie the rocks of F. VI. and F. VII. These spread out the formation in many changes of dip, causing chains of hills, in which the fossiliferous ore crops out upon the surface.

Iron Ores in Stone Valley.

About one mile south-east from Mill creek furnace, a deposit of ore occurs overlying F. IV. on the summit of Jack's mountain, which deserves mention from its peculiar position. From the ore digging, a

ravine runs up the slope of the mountain towards the east, on the north-west side of which occurs a ridge, embracing the upper sandstone of F. IV. The ore is on the very edge of the summit of the mountain, where it has been reached in a shaft of some depth, which terminates in a sandy clay containing the concretions. Reflecting on the circumstances which have given rise to this deposit, one can hardly resist the persuasion that a large bed of ore in this situation is rather improbable, and that its present sandy character will not give place to a purer one, when the mass shall be penetrated deeper.

The fossiliferous ore of F. V. merits much more attention, and deserves a diligent examination by mining, on the part of those interested in this valuable mineral. Though only one or two openings have hitherto been made in the bed, our efforts to trace it were in some degree crowned with success, owing to the useful clue afforded by a previous investigation of the range of the several axes or lines of elevation, and of the precise place in the formation to which the ore appertains.

The lower shales of F. V. are olive and yellowish; those adjacent to the ore are of a deep buff color. Over these are layers of a hard white or greyish-white sandstone, breaking into rhomboidal fragments. This rock, which is not always present, is distinguished by its abundance of fossil *enerini*. Its thickness is less than in the Lewistown valley, but its fragments are more scattered at its out-crop at the surface, in consequence of its inferior hardness. The weathered pieces have a rotten, worm-eaten aspect, and a dirty yellow color.— This rock is well known throughout the valley, and I therefore wish to attract especial attention to it as the best guide I can suggest to the position of the ore. It will be remembered that in the Lewistown valley a similar encrinuritic sandstone occurs invariably just below the ore; here, on the other hand, it seems to *overlie* it. The reverse of this order of things prevails, however, at one of the excavations undertaken for Messrs. Dorsey and Green, not far from the passage of the Little Juniata through Tussey's mountain, the ore here seeming to rest above the sandstone, as in the Lewistown valley. The ore has been opened to the north-east of Dorsey's forge, in the south-west flank of a hill running parallel to Tussey's mountain, in strata dipping twenty-five degrees to the south-east. The bed is nearly eighteen inches in thickness, and the ore is of the hard calcareous variety. It shows the usual rectangular fracture, and is of excellent quality. The analysis to be found in Chapter VI., will show its composition.

Directly under the ore lies a bed of olive colored slate, supported by a massive stratum of hard encrinuritic sandstone. Higher in the same hill, the weathered fragments of the sandstone are abundant. The position of the seam of ore is not favorable to its being easily excavated, and the narrowness of the summit along which its out-crop lies, preventing a sufficient percolation of water, has caused the ore to retain its original compactness and calcareous nature, even near the surface where usually, under more propitious circumstances, the ore is soft and porous.

On the same ridge with the above, between the Little Juniata and the Pennsylvania canal, Messrs. Dorsey and Green have made three or four openings. The most important is the one furthest north-east, where the vein is *a foot thick*, exhibiting some variety in composition and hardness; the hard *calcareous variety* lies above, then another less hard, and a third kind which is quite soft, apparently resulting from the decomposition of the harder variety, succeed. Under this seam occurs the massive *encrinitic sandstone*, occupying a different position from that which it usually observes further to the north-east in this belt. The dip being steep, the most eligible mode of mining it would seem to be to cut a tunnel to it from the base of the hill. Dr. Dorsey has excavated for the ore along the base of Stone mountain, and finds it of insufficient thickness to be valuable. It has been partially opened on the canal, where it is four inches thick, dipping seventy-five degrees to the north-east, and separated from the red shale in the upper division of the formation by two hundred and twenty-five feet of olive, buff and other colored slates. It has been opened elsewhere in the same range, at points where its thickness continues inconsiderable.

Further towards the north-east, the fossiliferous ore has been developed by Messrs. Alexander and Diarmid, in a hill of F. V., which terminates near the furnace, and which curves westwardly and joins another hill on the opposite side of the point of Broad mountain.—Where the stratum expands at the junction of these two hills, the ore has been opened. Fragments of the ore occur abundantly on the surface, but the seam is not visible in several little shafts which were dug a considerable time since. The presumption is, that the bed, if reached at all, proved too thin. At this place the ore probably overlies the buff shales, visible in the shafts. On a road crossing the hill, and at a lower level than these excavations, the ore bed has been opened, dipping nearly to the west; at one spot, where the bed reaches the surface, it appeared, when fairly developed, to be two and a-half feet thick, though at a place thirty feet from this, where it lies under a deeper cover, it is about twenty inches in thickness. The ore at this place is certainly of excellent quality, containing much of the softer variety, near the outcrop, in consequence of the gentleness of the dip, which does not exceed fifteen degrees to the west. The above openings, constitute the only localities in the valley where the ore has been dug, though we have traced it in many places on the surface, where the indications are favourable, both as to quantity and quality, taking care in all cases to direct the attention of the owners of the tracts to its concurrence. The localities will be mentioned in another place.

The openings made by Dr. Dorsey are the only ones where the ore was detected along the base of Jack's or Stone mountain. The anticlinal axis of Broad mountain prolonged, has caused two hills which contain the ore. It is only at the junction of these that the ore has hitherto been opened; but as these hills continue on both sides of the end of Broad mountain, there is no doubt that the ore can be

found in other places on these hills to the east and north-east of the present excavations. The southern hill terminates at the furnace, and it is doubtful whether the ore continues thus far, the strata having been much cut away by denudation. The range of the northern hill is not easily traceable.

The anticlinal axis of the spur of the Seven mountains, next north-west of Broad mountain, in entering the valley, throws up a hill of F. V., disclosing the ore near Mr. Cornelius Davis's. It continues at the surface but for a short distance. No fragments of the ore itself were discovered, but the encrinitic sandstone, and also the olive slate, both indicative of it, are visible. The indications at this spot authorize a search for the ore. The anticlinal axis above mentioned, extends into the limestone of Warrior ridge. The next mountain spur on the north-west, which we shall call the Bear Meadow mountain, divides into three ridges, each containing an anticlinal axis. That next the south has elevated the ore which may be seen a little south of Mr. George M. Bell's saw mill, and which continues thence about a third of a mile north of Ennisville, and directly north of Salsburg. Information that it contained the ore, was important to the proprietors interested, though no particular localities were found where the ore was abundant on the surface; the strata here dip to the south. No difficulty need exist in recognizing the hill, as it is well marked by a profusion of fragments of the *encrinitic sandstone*, in a much weather eaten condition. No prominent hill is here visible corresponding to this, containing the north-west dipping strata of this axis. The same difficulty occurs in tracing the ore hills related to the middle axis of the Bear Meadow mountain, at least none are visible along a section from Ennisville to Steffy's tavern. Crossing the rocks south-eastward, however, a long another line extending from a group of houses, three miles north-east of M'Murtrie's tavern, we detect the encrinitic sandstone. At this anticlinal axis, it is very doubtful, however, whether the ore itself extends thus far. The same axis is observed in the red and green shales above the ore, in a section made south of M'Murtrie's house, beyond which it ceases. The next axis of elevation, is that of the north-western spur of Bear Meadow mountain; this has uplifted the ore in a hill easily recognized. It is about one mile from Steffy's tavern, and has a small shanty at its northern base. Many specimens of the ore were found of a moderately good quality, in an open field belonging to Mr. Steffy, to whom it was pointed out. The same ore is found on the land of Mr. Thomas Blair, a mile and a half from Steffy's, apparently in the same range. It is seen again in the same ridge, a fourth of a mile from Blair's on the farm of Mr. Starr, and might readily be traced through other farms along the ridge, by observing carefully the indicating rocks. Another ore ridge occurs on the north side of Mr. Jonas Rudy's farm, at a little burial ground. This probably unites with the one above mentioned, when the two hills continue as one, passing a few yards south of M'Murtrie's tavern, and dying out between three and four miles further to the south-west. Appearances indicate that the ore is not prolonged as far to

the south-west, as where our section crosses the strata, two and a half miles north-east of M'Murtrie's. A few judicious excavations would determine this point.

The next prominent hill containing the ore, runs north of Mr. Jonas Rudy's farm, passing Mr. William Johnson's house, and extending a short distance south of Mr. M'Mahen's, four and a half miles east of M'Murtrie's. It is traceable eastward in the form of an anticlinal hill, to the road leading from Steffy's to Pinegrove, where it divides, the northern spur passing through Mr. Lighteren's land, and the southern running immediately north of Mr. James Leonard's. The axis itself is prolonged into a short ridge of the sandstone F. IV. Throughout most of this part of the belt of F. V. the ore may be sought for with a fair prospect of success.

The next ore hill commences, on Mr. Maffit's place, north of the one last mentioned, his fields showing an abundance of moderately good ore. The belt ranges along the flank of a ridge of F. IV., and extends through Mr. Robert Moore's farm, and thence along the flank of Stoney ridge through lands of Mr. Roberts, the ore appearing in the soil in both places. This ore ridge is joined by another ranging along the north-west side of Stoney ridge, the axes of the two ridges united, being visible in a section from Dorsey's forge to Petersburg, on the east side of the Little Juniata.

The next exposures of the ore are in some low and indistinct hills connected with *Round Knob*, which rises north-east of the forge.—The belt in which the excavation here made occurs, is that on the north-west side of the anticlinal axis of *Round Knob*. This range of ore extends with occasional interruptions along the summit of a ridge of the encrinitic sandstone, which traverses Hartzlog valley, running through a farm belonging to Governor Porter, and thence into Woodcock valley. The information imparted to the proprietors of lands containing this valuable bed of ore, concerning its exact position and range, will incite them, it is hoped, to search for it by actual excavations.

Another but unimportant seam of ore, occurs higher up in the beds of F. V. It has already been alluded to, when treating of the fossiliferous ore of the formation in Lewistown valley, but neither there nor in Stone valley does it promise to be of any value.

Iron Ore in the Limestone F. VI.

Attempts have been made to procure a supply of ore from the limestone belt at the base of Warrior ridge, especially by Mr. Diarmid.—The ore scattered on the surface, resembles somewhat that near the top of Jack's mountain. Some specimens procured from a shaft, seventy feet deep, sunk through sand and clay, were tolerably good; but neither the structure of the ridge, nor the nature of the overlying soil, warrant high expectations of our finding here a useful deposit of good ore. On the same ridge, not far from Couch's forge, fragments of ore of small size are abundant on the surface, and several shafts

were at one time dug on a farm belonging to Mrs. M'Gill, but without success. The promise of a deposite of ore of any magnitude in this belt of limestone F. VI. is by no means encouraging.

Clay.

In addition to the ore on Diarmid's place, there is a stratum of white clay, which, according to experiments, seems to answer for the manufacture of fire-brick and crucibles. Specimens were presented to the State cabinet by Mr. Diarmid. It lies in a ravine running transversely to the course of Warrior ridge. Its cover is chiefly sand, derived from the disintegration of the sandstone F. VII.

SECTION IV.

Of the belt of country lying south-west of the Juniata, and between Jack's mountain, and Tussey's mountain.

The next district to be described is the prolongation of the wide belt of the formations which terminate in Stone valley. By the interposition of Sideling hill and Terrace mountain, which terminate together in a high synclinal knob on the south-west side of the Juniata, the general belt before us is divided into three parallel lesser vallies, known as Hare's valley, Trough Creek valley, and Woodcock valley. One principal synclinal axis, traversing the middle of these, or the valley of Trough creek, the same formations rise to the surface in the two opposite vallies of the belt; that is to say, in Hare's and Woodcock vallies, the same rocks dipping to the north-west in the former, which incline to the south-east in the latter. The geology of these two exterior vallies is therefore very similar, while their general structure is remarkably simple. That of Trough creek, on the other hand, is more diversified, and becomes highly interesting when we enter the Broad Top coal basin, which occupies its centre. After devoting a few remarks to Hare's and Woodcock vallies, I shall proceed to describe Trough creek valley, and a portion of its coal field.

Hare's Valley.

The above name is given to the narrow belt included between Sideling hill and Jack's mountain, ending at the Three Springs. Its features are remarkably simple and regular. Sideling hill bounding

it on the W. N. W. is a straight ridge of even summit, the outline of which, for many miles from the Juniata, is scarcely varied by a depression. Its eastern side is usually steep, consisting of the red argillaceous sandstone F. IX. for a considerable height. The summit and north-western slope, are formed of the harder grey sandstone, F. X. Clear ridge consisting of the slate, F. VIII., extends continuously through the valley. Its north-west side from the base half way up, is occupied by the lower beds of F. IX., F. VIII. spreading from this margin to the base of Rocky ridge, which is composed of the fossiliferous sandstone F. VII. The little valley between Rocky ridge and the base of Jack's mountain includes the limestone F. VI., and the red and variegated shales F. V. The limestone F. VI. is quarried in a few places; and it may be useful to offer a few hints at present, respecting the position of the purer varieties of the rock. At a quarry about one hundred feet from the east base of Rocky ridge, and near Mr. Humphrey Chilcoat's, the beds exposed, are rather siliceous and abound in fossils. The rock exhaults a fœtid odour when struck. One bed here is of a purer quality. These layers occur near the base of the sandstone F. VII., the purer portions of the limestones lying from twenty to fifty feet further east from the base of Rocky ridge.

Another quarry owned by Mr. Jacob Crotsley, about five miles south-west from Chilcoat's, holds the same position and displays nearly the same layers. In the neighborhood of the present quarries, the underlying layers, it is true, could not be readily reached, but between Chilcoat's and Crotsley's, spots could be selected where they would be accessible.

F. V. and Iron Ore.

No ore is observable in any part of the belt of red shale F. V. until we approach the end of Jack's mountain, where two hills containing the fossiliferous ore arise. That towards the north-west, is crossed by the road leading from Three Springs to Bell's furnace.

The limestone layers of F. V., were only found in one locality, which is in the neighborhood of Three Spring creek, where they are fully developed; some of them consist of good limestone adapted to making lime; others have the siliceous character usual in these beds.

Formation VIII.

Layers of a blue calcareous sandstone passing into a siliceous limestone, occasionally fossiliferous, occur in the lower portion of F. VIII., on the Juniata. This seems to be the representative of the *cement layers*, found in other belts of the formation. A similar bluish calcareous rock, too impure, however, to furnish lime, may be seen on Mr. Crotsley's farm, between his house and Rocky ridge.

Woodcock Valley.

In giving a sketch of Woodcock valley, I shall embrace the whole district included between Terrace mountain on the east, and Tussey's mountain on the west. That portion of this belt lying between Terrace mountain and Warrior ridge, is traversed by four distinct ridges, consisting chiefly of the slate F. VIII. These form a line of bold bluffs on the south side of the Juniata, a little below Huntingdon. The nearest Terrace mountain is called Allegripus ridge. Its summit is broad and undulating, embracing sometimes three minor summits. The beds composing the alternations of F. VIII. and F. IX., appear on the E. S. E. side of the main summit. The Raystown branch of the Juniata, generally flows between it and Terrace mountain, winding circuitously from base to base. Allegripus ridge is a regular range, traceable parallel with the mountain, to a point south-west of Hopewell furnace. Another slate ridge of F. VIII., having no name, lies north-west of Allegripus ridge. This is succeeded by Pine ridge. The fourth ridge, also appearing at the Juniata, ranges immediately south-east of Warrior ridge. It is obliterated occasionally for two or three miles by denudation.

Warrior ridge has been alluded to before. At M'Connellsburg, five miles from Huntingdon, it comprises two summits; but traced further to the south-east, it becomes a single ridge, consisting every where of the sandstone F. VII. In the valley between Warrior ridge and Tussey's mountain, the limestone F. VI., immediately at the base of the ridge, is succeeded by low hills of the coloured shales of F. V., the ore bearing portion of the formation lying adjacent to the foot of the mountain. These low hills result from a series of minor undulations in the strata, derived from the axes of elevation, existing towards the north-east. They are apparent opposite M'Connellsburg, and also in a section made at Mr. Matthew Garner's, twelve miles from Huntingdon; but they disappear before we reach the ore diggings of the Trough creek furnace.

Iron Ore F. V.

The fossiliferous iron ore lies in a ridge containing the enneritic sandstone which traverses Hartzlog valley, and is prolonged a short distance into Woodcock valley, passing through a series of farms, one of which is the property of Governor Porter. Further towards the south-west, the ore appears near the base of Tussey's mountain, but does not occupy a distinct ridge. It is found at the foot of the mountain, on the road leading from Mr. Matthew Garner's, immediately north-west of the last house. Specimens of the ore—not such, however, as to enable us to judge of its thickness or quality—occur upon the surface.

The fossiliferous ore has been opened to some extent by Mr. Savage, for his furnace, about a third of a mile north-west of the Bedford road, and between fourteen and fifteen miles from Huntingdon. These dig-

gings were prosecuted for about four years. The principal band varies from twenty to twenty-five inches in thickness. The encrinitic sandstone, of a spongy and porous structure at its outcrop, overlies the ore, supporting in turn beds of yellowish slate. The strata here dip about forty-five degrees to the E. S. E. This ore, though belonging to the same belt of F. V., differs slightly in its aspect from that of Montour's ridge, being, on the whole, more laminated and more highly fossiliferous, and probably, at the same depth, somewhat harder.

The next place in which the ore is developed to any considerable extent, is at the openings which supply Hopewell furnace. These are situated several miles to the south-west of the former. Two distinct seams of the ore, separated by eight feet of slate, are stated to occur here—one consisting of the ordinary kind, the other of the hard, calcareous variety. The thickness of each was stated to be two feet. Owing to the want of time, consequent upon the lateness of the season, the mine was not explored. The ridge containing these excavations, sweeps round a knob of Tussey's mountain, and exposes the ore in another place, where it has also been developed for Hopewell furnace—one bed only having been found, however. By entering it at the end of the ridge, a breast of ore, nearly eighty feet from the drift to the outcrop, is made accessible.

The same ore occurs in two ridges between the last mine and that portion of Tussey's mountain through which the road passed into Morrison's Cove. Hopewell furnace has, for some time past, been supplied almost exclusively with this ore.

Trough Creek and Plank Cabin Vallies, and Broad Top Mountain.

The next belt to be considered, lies between Terrace mountain and Sideling hill, and embraces the four uppermost formations of one lower secondary series. The first of these, the grey sandstone and conglomerate F. X. forms the bounding mountains above named. The soft argillaceous shale, F. XI., occupies the general valley between these ridges, surrounding on every side the elevated table land of Broad Top mountain, filling Trough creek, Plank Cabin, Wells and Ground Hog vallies, and the little valley lying between Broad Top and Terrace mountains. Broad Top mountain, comprising F. XII. and the overlying coal measures, rises in the middle of this basin of the red shale in the form of an elevated plateau.

The sandstone F. X., forming the surrounding mountains, is finely exposed in the gap by which Trough creek finds a passage through Terrace mountain at Savage's forge. The strata, which at this place have a gentle dip, do not exhibit much diversity of character. The lower beds alternating with the upper red layers of F. IX. consists of a coarse grey and yellowish sandstone, of somewhat argillaceous texture, conspicuous, like most other portions of the formation, for its amount of *false bedding*. Overlying this is a stratum of buff colored slate, supporting beds of rather coarse micaceous sandstone, of various tints, greenish, grey and white. Still higher in the series are

massive quartzose, white sandstones, stained superficially by iron. Nearly all the rocks of F. X. are more or less ferruginous, containing many specks and blotches of the peroxide of iron, from which certain deposits of ore may have been derived by filtration. In these sandstones we occasionally find small plates or patches of genuine coal, rarely of greater superficial extent than the area of a single flattened stem or leaf of some fossilized plant. We also met with a little black slate. Ascending towards the contact of F. XI., the sandstone once more becomes yellowish and argillaceous, and is surmounted by the red and greenish shales of F. XI., with which these upper beds alternate. In these alternations lies an important bed of *iron ore*, to which I shall presently recur.

Red and greenish shales and argillaceous sandstones of the same colors, occupy the vallies of F. XII. already mentioned. Among the lower layers of the formation, we encounter an interesting band of limestone, found in Trough creek, Plank Cabin, and several of the other red shale vallies. This is probably the equivalent of the limestone, which occupies a corresponding position in F. XI., in the Allegheny mountain and other ridges bordering the bituminous coal basins of Somerset and Cambria counties, and which extend thence into Maryland and Virginia.

Formations XII. and XIII. will be described when treating of the geology of Broad Top mountain.

Physical features of the Region.

Commencing with the knob of Terrace mountain, which terminates the synclinal valley, in a remarkably symmetrical mountain, jutting boldly forward to the margin of the Juniata, the encircling belt of mountains here divides, and forms on the north-west Terrace mountain proper, and on the south-east Sideling hill enclosing an elevated basin-formed valley of the red shale, sloping with remarkable regularity from this extremity toward the base of Broad Top. Sideling hill running east of Chilcoatstown, bounds Well's valley on the east, while Wray's hill rising at De Forest's, three miles from Chilcoatstown, bounds the same valley on the west. After extending south some miles, this latter ridge curves rapidly backwards for some distance, when it again resumes its south-west direction, until it unites with Broad Top, to enclose the coal region. Opposite the curve, Harbour mountain commences, consisting of the sandstone F. V., elevated by an anticlinal axis. It separates Well's valley from another valley of the red shale F. XI., lying west of it, known as Ground Hog valley. Harbour mountain, dividing into two ridges, the eastern one curves eastward and unites with Sideling hill, thus shutting in Well's valley; the western one bending elliptically round the coal region to join Terrace mountain. This last named ridge ranges about south-west; tracing it along Trough creek valley, its south east side slopes less and less until within eight miles of Savage's furnace, where the ascent from the valley to the summit is not more than five or seven de-

grees. There is a remarkable projection in the mountain on the south-west side of Norris's notch: that section of the ridge being heaved to the west. Something of the same feature is perceptible at Trough creek gap, to which points the axes disturbing the coal basin, are distinctly traceable. The mountain from Trough creek gap to its junction at Harbour or Cross mountain, is extremely regular. The interval between the two ridges, is occupied by Broad Top mountain and its coal basin, the topographical features of which we shall now briefly sketch. In order to do this intelligibly, we must trace the position of its axes of elevation.

BROAD TOP MOUNTAIN.—*F. XII., and Coal Measures.*

The north-east extremity of the coal basin terminates in a series of spurs, formed by several anticlinal and synclinal axes. The portion of the coal field lying towards the south-west, not having been yet explored by us, we cannot trace with precision the prolongation of these axes, in that direction. Broad Top mountain throws out no less than four spurs into Plank Cabin and Trough creek vallies. The first, and most eastern of these, is *Shirley's knob*, or its continuation: the second is *Round knob*, one of the highest: the third is called *Broad Top*: and the fourth lying nearest Terrace mountain, has no distinctive name, but Broad Top. Another knob called Round Top, rising directly at the furnace, is situated apparently in a line between the last mentioned spurs. Shirley's knob, and its continuation, is of synclinal structure, and this axis prolonged north-eastward, is the axis of Trough creek valley. South-westward it passes through the centre of Rocky ridge, which is composed of two ridges, or at all events, may be described as having two summits, between which lies Savage's coal seam, the lowest bed in the series. After passing through Rocky ridge, which, properly speaking, terminates two or three miles south-west of Savage's coal mine, in a high conspicuous knob; this trough, or synclinal axis, crosses the little valley of F. XI., near Mr. Samuel M'Lean's, and enters the knob *there* known as Broad Top, beyond which we have not pursued it. The next spur or knob, called Round knob, from its nearly circular, level summit, constitutes the second lesser basin, formed by the synclinal axis, which, leaving it, enters another knob opposite to it, called Grave mountain, from whence it ranges through the coal region. The anticlinal axis interposed between these two synclinal ones, passes between Rocky ridge and Round knob, crosses the little valley near M'Lean's, and extends thence between Broad Top and Grave mountains, while in the opposite direction, it can scarcely be traced to Trough creek.

The third spur, otherwise called Broad Top, contains the third synclinal axis, giving it therefore a basin-like structure. The second anticlinal axis, included between this last and Round knob, elevates F. XI. in Plank Cabin valley. The next spur towards the west, contains the fourth synclinal axis, which either enters Round Top at the furnace, or passes to the west of it, leaving it as a hill of elevation,

thrown up by the third anticlinal axis, prolonged from between the third and fourth spurs. Most of these axes expire at Trough creek, thus spreading, in nearly horizontal position, the sandstone F. X. over a wide tract at the upper end of the valley, denominated the *Burrens*. Trough creek forms a natural boundary between this sandstone and the overlying red shale F. XI. Besides the axes already mentioned, there is a synclinal axis in Wray's hill, and an anticlinal axis between this and Rocky ridge. Wray's hill may be considered, geologically, as commencing at De Forest's, three miles south-west of Chilcoatstown, though it is continued by short and low knobs along the east flank of Rocky ridge and Shirley's knob. Further to the south-west, it acquires two summits under the title of Rocky ridge. The western ore widens beyond the end of Rocky ridge, and contains not only the synclinal axis, but an anticlinal one. Whether this latter traverses Wray's hill into the Harbour mountain is, at present, uncertain. Thus, at the north-east end of the coal region, we have in all, five basins in the strata, and four interposed anticlinal axes; an accurate knowledge of the position of which becomes of the utmost practical importance to develop the coal seams of this richly supplied region. These axes of elevation give to the surface of the general coal field of Broad Top an undulating outline, which has been rendered more irregular by the operation of great floods, cutting the flanks of this elevated table land into numerous deep ravines. The tangled thickets of laurel with which these are filled, and the fewness of good exposures of the strata, render the accurate exploration of this region a work of time and patience, and the late period of the season at which it was entered on, prevented our completing its investigation. Towards its south-west end, the structure of the region becomes somewhat easier to recognize, the exposures of the rocks furnishing more ample data. Another season, it is believed, will place us in possession of full information respecting the number, relative position, and range of the several coal seams and beds of iron ore, some details respecting which, I shall presently return to.

Directing our attention first to the resources of the surrounding red shale vallies, let us allude to the limestone and iron ore which belong to the bottom of F. XI.

Limestone.

A bed of greyish or clouded white limestone, occurs near the alternation of F. XI., and the subjacent sandstone. This rock is somewhat siliceous, and probably quite magnesian, burning with difficulty into lime. It is also slightly fœtid, and breaks, by exposure, into conchoidal fragments. In some localities it is purer, and has a smoother grain. This band of greyish limestone is from two to three feet thick. It has been opened on Little Trough creek, where it is nearly horizontal. Above this bed, lies a reddish limestone, about the same thickness, supporting a red shale, which is decidedly calcareous. These red and grey limestones are evidently equivalent to

those which occupy a similar position in the series, west of the Allegheny mountain. A variety, having a finer grain, is found on Mr. Adam Lovel's farm. Here the rock is smooth, and has a cherty lustré; it makes a dark lime. The belt continues north, along the edge of the Barrens, through several farms; the layers being well exposed. Another belt should extend along the base of Sideling Hill, where hitherto it has not been sought for; the limestone following Little Trough creek to its junction with Big Trough creek, ranges near to this stream through Plank Cabin valley. A short distance from the furnace it is again quarried; is about three feet thick, and overlaid by calcareous red shale; it has been employed as a flux in the Trough Creek furnace. This belt should range through Little valley, between Terrace Mountain and Broad Top, near the base of the former. It is exposed on the road to Stonestown; it is visible at several points in Well's valley.

Iron Ore.

There is a massive variety of iron ore, which has been opened to some extent, near the Trough Creek furnace, and also in the vicinity of Hopewell furnace; it occupies a position at the very base of the red shale, at its contact with the underlying sandstone of F. X. Occurring in the gently inclined plane at the base of the mountain, this seam of ore might be naturally supposed to result from the percolation of water through the ferruginous sandstone of the mountain, but we hesitate in adopting this conclusion, when we reflect on the position of the ore at Hopewell furnace, where it appears to exist as a regularly interstratified bed between the rocks, much in the same manner as we find the fossiliferous ore in F. V. The excavations attached to Trough Creek furnace, are situated at the base of Terrace mountain, about one mile from the forge. The ore lies in lumps closely bedded together, suggesting, by the regularity of their position, and by the absence of much interposed earth, that they belong to the outcrop of a continuous bed. It exists in about five different varieties, several of which are very compact forms of the ordinary brown iron ore. When smelted by itself, it is stated to produce a highly coldshort metal. The analyses to be found in chapter VI., will exhibit its chemical nature.

The same ore is opened near *Hopewell furnace*, on both sides of the gap in Terrace mountain. The excavations on the north-east, are open to the day, but on the south-west side of the gap, the ore has been reached by a regular tunnel, ninety yards in length, intercepting the vein ninety feet below its outcrop, on the slope on the mountain. An air shaft extending up the vein, from the tunnel to the surface, exposes it, varying in thickness from twenty inches to three feet. Galleries or drifts have been made in both directions from the tunnel, but the seam of ore diminishes in thickness, and threatens to thin out. A shaft has been subsequently sunk, reaching the vein at a point forty feet below the level of the tunnel, where it retains the same

thickness as above. It lies immediately at the contact of the sandstone with F. XI. It is interstratified with more or less clay. The ore here is of three kinds, the most abundant being brown, brittle, and of a smooth jaspery fracture, resembling closely one of the varieties at Trough creek. This species is said to make good iron, and to yield fifty per cent., which certainly seems to be a large amount. The second variety is of a more yellow aspect and slaty structure. The ore in the open diggings, on the opposite side of the gap, occurs also between the sandstone and red shale. The contour of the hill side, at this place, is such as not to imply an origin from infiltration; the ore appearing rather to be the outcrop of a regular vein. The adjoining red shale occurs in thick layers, which are soft and friable, and sometimes of a bright red hue, immediately contiguous to the ore. Near the margin of the deposit, thin layers of a sandy ore are interstratified with the red siliceous shale or sandstone, and approaching the vein, the red shale is disintegrated, passing to a sandy clay. Towards the middle of the deposit, the ore is both sandy and argillaceous. The principal mine is about 100 yards in length, and open to the day. The coarse yellowish white sandstone, F. X., forms one side of the deposit from which the ore has been removed. This bright red clay included among the ore, answers as a substitute for paint.

Iron Ore between F. XI. and F. XII.

In the alternating beds at the junction of F. XI. and F. XII., we meet with fragments of ore of a light chesnut brown color, similar to one of the varieties found in F. V. It would seem to be neither rich nor abundant. This ore is visible at the north-east end of Wray's hill, which is composed of these alternating rocks; and it occurs also in several other positions, easily traced by attending to the stratification, and the range of the axes previously mentioned.

Broad Top Coal Region.

The sandstone, F. XII., which immediately underlies the coal measures of Broad Top, possesses little of the conglomerate character which distinguishes it where it borders most of the other coal fields of the State, both in the anthracite and bituminous regions. It is hence not readily distinguished, in all cases, from some of the sandstones included between the coal, though a careful observer will find but little difficulty. The overlying coal measures appear not to be extensively developed, until we reach the central and south-western portions of the basin. After devoting a general, but tolerably minute examination, to be renewed hereafter, to the several spurs projecting into Plank Cabin valley, we have reached the conclusion that none of these synclinal axes, but Rocky ridge, contains any coal. The seam in Rocky ridge terminates about one-fourth of a mile south-west of the gap at Trough creek, the sandstones of F. XII. occupying, after-

wards, the whole summit. It does not apparently prolong itself into Shirley's knob, the peculiar form of which seems to preclude its existence there. The sandstone, F. XII., occupies this hill from the creek to the summit of the knob. We shall allude in another place to the range of the coal seam through Rocky ridge. As the red shale, F. XI., extends far up the flank of Round knob, there is but little possibility of a coal seam in this spur; and the occurrence of the same stratum, nearly on the summit of the Grave mountain, in the same bearing as Round knob, is a further corroboration of this opinion. For a similar reason, the existence of a coal seam in either of the other two spurs of Broad Top, which extends into Plank Cabin valley, is somewhat doubtful; but this point will be definitely settled during the coming season. On Round Top, near the furnace, no bed of workable coal, we conceive, can occur. The alternating beds at the passage of F. XI. into F. XII., may be observed in a knoll on Trough creek, opposite to De Forest's, which is a continuation of Wray's hill. These consist of yellowish and greenish sandstones, red shales, and again of layers of a fine grained, very argillaceous green sandstone, making admirable whetstones; these beds indeed furnish whetstones in many places surrounding the coal region. Underlying the coal seam at Savage's mine, there is a stratum prominently exposed on the west side of the ridge, of a hard and massive, but fine grained white sandstone, speckled with mica. The angular fragments of this rock enable us easily to trace it through Rocky ridge. It is again seen a mile and a-half south of Savage's mine, on the eastern ridge, supported by a brownish grey sandstone. Below the latter are massive beds of a white sandstone, composed of granular milky quartz. Pursuing F. XII. along Rocky ridge, the upper sandstone maintains its character, while the lower bed becomes coarse—containing grained white quartz pebbles of the size of a grain of pepper, showing thus an approximation to the conglomerate type of the formation.

Where Trough creek rushes between Rocky ridge and Wray's hill, two and a-half miles south-west of De Forest's, is a high escarpment of sandstone, called the *Raven Rock*. The best exposed strata here underlie all of those above described, and consist of grey, whitish, and brownish hard sandstones, generally coarse grained, including occasionally thin layers of black carbonaceous shale containing vegetable impressions.

The Coal Seam in Rocky Ridge, has been opened adjacent to the western summit, about three-fourths of a mile S. W. of the gap occupied by Trough Creek. The coal dips at the mine sometimes towards the south, though more frequently south twenty-five degrees east, at an average angle of twelve or fourteen degrees. It is about four feet thick, is of excellent quality, and convertible into a good coke. Numerous oblique transverse joints divide it into rhomboidal fragments. The seam is overlaid, and also supported by solid layers of dark fine clay, each about six inches thick, which by exposure are converted into a plastic clay.

Another mine has been opened in the same range, about one and a half miles south-west of Mr. Savage's, where the coal bed is stated to be four feet thick. The excavation has become obliterated. The seam probably exists at intervals from this point, nearly to the end of Rocky Ridge, though it is not easily traceable. Indications of it occur above the Raven Rock, rather north of the high knob which terminates Rocky Ridge.

Wray's Hill.—For several miles the summit of Wray's Hill consists of the alternating beds of F. XI. and F. XII. Mr. Stumbaugh's coal diggings, lie about three-fourths of a mile north-east of Deever's and extend from near the summit of the west ridge to the ravine between the two summits. The coal seam at this place has an insufficient covering which renders it soft; it is also slaty. Its position is somewhat singular, the alternating beds of F. XI. and F. XII. occurring not more than two hundred yards west of the highest opening. The dip of the intervening strata appears not to exceed twenty-five degrees, making the extreme thickness of F. XII. not more than two hundred feet, which accords well with the observations made at other places. The rocks adjoining the coal, are different, however, from those near Mr. Savage's mine. At the upper opening, near the west summit, the strata dip twenty degrees to south seventy-five degrees east, and in the level space between the summits they are nearly horizontal, beyond which they dip slightly to the west. The alternating beds of F. XI. and F. XII. occupying the western summit, are traversed by an anticlinal axis, which causes this summit, in its range to the south-west, to become a broad and level hill, called *the Barrens*, which is opposite Deever's; it is nearly a mile in width. In this quarter the only coal seam on the hill is M'Lean's, opened two miles from Deever's. The surface rises into a circular knoll from the general level of the barrens, and around the brow of this upper hill is the outcrop of the coal seam. The excavation here having become obliterated, the thickness of the coal could not be measured, but it is stated to be four feet, the bed being separated by three inches of slate into two portions. It rests on slate and is overlaid by sandstone. It is said to be a light inflammable coal, readily consumed.

Houck's coal diggings occur two miles from M'Lean's mine, in a W. N. W. direction near Trough creek, where it separates Wray's Hill from Broad Top. The dip of the bed is about six degrees, and the difference of level between M'Lean's and this opening, is very trivial. The coal occurs in two benches, the lower varying from one to two feet in thickness, and the upper from one foot to one and a-half feet, the intervening slate exceeding, generally, one foot. The seam is overlaid by slate, containing some layers of sandstone. The coal contains more sulphuret of iron and is more slaty than that at Mr. Savage's mine. Its identity with M'Lean's bed, has not yet been positively ascertained.

A seam of coal, called Cook's vein, has been opened near the margin of a brook on Broad Top. It comprises four separate bands of coal; the first, varying from twelve to sixteen inches, is a little sulphu-

rous and slaty, and is overlaid by four or five inches of slate; the second is five inches thick, much lighter than the rest, and overlaid by sixteen or twenty inches of slate; the third is an excellent coal, two feet in thickness, covered by three inches of slate, and the fourth, or uppermost, is about ten inches thick, overlaid by about three feet of slate supporting dark grey sandstone with vegetable impressions. The dip at this spot is variable, as it also is between this opening and Mr. Phillip Barnett's on the creek. Whether these two belong to one bed, or constitute two independent streams, a future season must decide.

At Barnett's opening, the bottom slate is very compact, and contains some sulphuret of iron. The lowest band of coal is twelve inches thick, and is used by the blacksmiths. Resting upon this, a slate occurs, five inches thick, and over this a superior coal, two feet ten inches in thickness, one of the purest on Broad Top. Above the coal lies a compact olive slate, which, if procurable in pieces of proper shape and size, would make a tolerable writing slate. Near the coal bed occurs some *nodular iron ore*.

Coal has also been found near Mr. Henry Horton's. There appear to be two seams on the farm of Mr. Henry Miller, and likewise on that of Mr. George Houpt, on the opposite side of a deep ravine. At the latter spot, the lowest, measures between two and three feet in thickness. Coal also occurs on the farm of Mr. Christian Barnett, one mile from Phillip's, where it also exists.

Towards the south-west end of the basin, occurs the *Riddle mine*, situated on Six Mile run, emptying into the Juniata, two miles below Hopewell. This appears to be the thickest seam of the Broad Top basin. For a considerable distance in from the mouth of the drift, it measures about five feet, swelling in some places to from ten to twelve feet. The roof is regular but the underlying slate is very uneven, sometimes rising rapidly and encroaching on the coal which is harder and less bituminous than much of the other coal in the region. This bed is not divided by any thick layer of slate, but little bands, only a fraction of an inch in breadth, often adhere tenaciously to it. Though the above opening is the most western on Broad Top, it seems doubtful whether it can belong to the lowest seam, for, were it so, the underlying sandstone F. XII. must exist here in far greater thickness than we have reason to suppose it does. At some distance from the mine the bed ultimately rises to the east, cropping out in the ravine which separates the hill in which it lies, from another further eastward. This latter hill, containing an anticlinal axis, the coal has been swept from it by denudation. The same bed should crop out on the east side of this hill, and accordingly we find on the road to Tigard's mill, a black slate connected with this coal seam.

On the creek between the second hill and Tigard's mill, another small seam about eighteen inches thick is said to show itself, there are several openings along Six Mile run, besides those above mentioned, but want of time has hitherto prevented their being examined. A section carefully measured along this stream would prove a valuable

guide in determining the number and relative position of the coal seams of the basin.

Coal has been opened on the farm of Mr. James Tigard, a mile and a-half from the hill. It dips south, and is said to be two and a-half feet thick. About two miles from the mill, another excavation on the land of Messrs. Lloyd and Patterson, occurs in coal said to be five feet thick, dipping to the south; and another is to be seen at Mr. Richard Foster's, three and a-fourth miles from the mill, where the bed is two feet thick.

Near Trout run, about three and a-half miles from Hopewell furnace, occurs a valuable seam of coal, dipping seven degrees to the W. N. W. but becoming more inclined as we recede from the outcrop. In the main drift of the mine this bed is upwards of five feet thick and increases to seven and even eight feet. The overlying slate is hard and heavy and like that of the bed at the Riddle mine. The two coals also resemble each other, and belong probably to one seam, though they occupy different positions with regard to the axis of elevation. Like nearly every other bed of bituminous coal, it contains thin laminæ of slate, and a little sulphuret of iron. Between the above large vein and Hopewell furnace there is another, appearing about a mile and a-quarter further west, which is eighteen inches thick. This is probably that which overlies the Riddle bed, and if so, the principal seam should be found at a lower level in the small ravine of the mountain. One point is clear, that the seam at present worked for the supply of Hopewell furnace, should crop out at least in three different places nearer the furnace than where the mines are now established. This information was imparted to the manager of the furnace.

SECTION V.

District between Tussey's mountain and the Allegheny mountain.

The next belt of country embraced in the investigations of the past year, in the portion of the State before us, comprehends the interesting chain of vallies lying between Tussey's mountain and the base of the Allegheny. The exploration commenced in the neighborhood of Pine Grove, west of the termination of Stone valley, and extended to the southern end of Morrison's cove, the close of the season arresting our further progress. The north-eastern extension of this belt through Centre county, was examined in much detail during the previous summer.

Commencing our present brief account of the formations, with a sketch of Tussey's mountain, we shall trace this ridge from Pinegrove to the Raystown branch. Between Pinegrove and the Little Juniata river, the structure of the mountain is rather uniform. The white sandstone, the upper of the three divisions of F. IV., forms a nearly straight, occasionally undulating summit, in which the depressions are few and not deep. A terrace or bench occupies its north-west slope, a considerable distance below this crest, intersected as usual, at intervals averaging about three-fourths of a mile, by deep ravines, or short vallies of denudation. In some places, the terrace nearly rivals the principal summit in height. Approaching the river it becomes more depressed, the ravines more numerous; and the northern slope of the mountain more abrupt. Still nearer the Juniata, the proofs of violent denudation by water are still more striking, the margin of the terrace appearing sometimes as a bold escapement of the lower grey sandstone of F. IV. That section of the ridge, included between the Little Juniata and the main river, called Short mountain, present a regular summit; but the denudation has been such as to leave scarcely any terrace. From the Frankstown branch south-west for a few miles, the mountain does not reach its usual elevation. The river here has its course in the soft red argillaceous rocks, composing the middle division of the formation, leaving the lower sandstone in a small, sharp, isolated ridge of the shape of a colossal grave. This is about two miles long, the river intersecting the lower sandstone by a gap above which it flows in the slate F. III., and the limestone F. II. of Canoe valley.

About five miles from Alexandria, the whole mountain exhibits a remarkable displacement in its course, forming a flexure like the letter S, caused by the folding round of the formation over a short anticlinal axis, which runs obliquely from the main axis of elevation of the valley. South-west of this curve it pursues a regular course, with some trivial inequalities, to Yellow Creek, ranging about south thirty degrees west, while its direction north-east of the Little Juniata, is about south seventy degrees west. Approaching Yellow Creek, there are several unimportant notches in the main summit of the ridge, but no true gap exists until we advance within a few miles of another double flexure of the mountain near Yellow Creek. North-east of this stream occurs a flexure similar to the former, produced by the termination of an anticlinal axis deflecting the mountain for a space out of its regular course. This axis of elevation is continuous with that which produces a corresponding flexure in the Muncy mountain, enclosing Brush Valley. From the neighborhood of Yellow Creek, the mountain becomes higher, more regular, and exhibits less waste from violent floods, the terrace rising to a great elevation.

At the gap of Yellow Creek, the strata dip forty degrees to south seventy-five degrees east. From this point to the gap at Raystown Branch, the formation is uninterrupted, presenting merely a slight deviation in its course near the termination of Morrison's Cove, curving

a little more towards the meridian, where it forms the east side of Snake Spring Valley.

The slate F. III. ranging at the base of Tussey's mountain, skirts the eastern side of the Great Limestone Valley, throughout its entire length, maintaining great uniformity in its aspect and structure. At the contact of this rock with the overlying sandstone of F. IV., we perceive layers of black and dusky olive slate, alternating with dark argillaceous sandstones. Approaching its inferior limit, the slate begins to alternate with dark argillaceous limestones; these calcareous bands, increasing in number and thickness as those of the slate, progressively diminish.

Along no portion of the belt does the slate appear as a very thick stratum, its maximum depth probably not exceeding six hundred feet. It generally composes the lowest part of the activity of the mountain, sometimes extending nearly to the verge of the terrace on its side when the denuding action has been relatively feeble. At Lower Colerain Forge, near the Little Juniata, it gives proof of considerable waste by floods, Spruce Creek having its channel in this slate, sweeping the foot of the terrace, while the dark grey sandstone, the lower division of F. IV. rises from the stream in a tall escarpment or wall. At the folding round of Tussey's mountain opposite Williamsburg, the slate is embraced in the recess, forming two short hills jutting forward at right angles from the main ridge.

Limestone F. II.

The anticlinal axis of Brush valley, elevating to the surface, the limestone F. II., near the head of that remarkable nook, terminates in Morrison's Cove, south-west of Martinsburg.

The country between Tussey's mountain and the first range of barrens, traversing the central part of the main limestone valley, north-east of the Juniata, is a gently undulating surface, along which the limestone is elevated by an anticlinal axis, prolonged from Penn's Valley. The banks of Spruce creek, exhibit occasionally fine exposures of the strata, forming the south-east side of this axis, while Warrior Mark run intersects it diagonally. The little Juniata itself exhibits a section of this part of the belt, showing satisfactorily the true position of the axis. The rocks on the south-east side of the line of elevation, dip to the south-east at an angle of about forty degrees, while the inclination of those on the opposite side, to the north-west, is somewhat steeper. A section a few miles further to the south-west, displays a change in the position of the strata. Crossing their outcrop from the end of Cove mountain to Tussey's mountain, the rocks on the north-west side of the axis are nearly vertical, while those south-east of it, though sometimes steep, have generally a less inclination. The line of elevation in the limestone, takes here a course more towards the south. The belt of the valley between the two mountains is elevated, and the slate spreads to a considerable distance from the base of canoe Mountain. The valley sometimes called Canoe valley,

is traversed south-westward by the axis, preserving the same nearly vertical attitude, in the strata along its north-west side. The Juniata river, after crossing the valley at Williamsburg, winds along the south-east side of this axis, sweeping sometimes the base of the mountain in the slate of F. III., sometimes cutting through the limestone almost to its line of elevation. The only interruption which this anticlinal line presents, is when it sends off the short axis of elevation, which causes the flexure in the mountain south-east of Williamsburg. Beyond this point, to the other similar bend in the mountain, at Yellow creek, opposite which the axis terminates, it is remarkably regular. This axis, which we have been tracing, terminates in the little sharp cove, south-west of Martinsburg.

In the wide limestone valley, embraced between Tussey's mountain and the Bald Eagle or Muncy mountain, we have two parallel anticlinal axes; that on the south-east being the same which elevates the rocks in Brush and Penn's valleys, and that on the north-west, the prolongation of the axis of Nittany valley, the included trough or synclinal axis, being the same which contains the Nittany mountain. About ten miles south-west from Bellefonte, the Nittany valley axis loses its symmetrical structure; the strata lying north-west of it becoming vertical, and soon afterwards *inverted*, ranging in this attitude through Halfmoon and Warrior Mark valleys, into Sinking valley, five miles south-west of the Little Juniata. Here the rocks resume their more natural posture, dipping to the north-west until the axis terminates south of Hollidaysburg.

The trough or synclinal axis of Nittany and Canoe mountains, is occupied by an extensive range of sandy barrens, which stretches almost uninterruptedly from the bed of the one mountain, to the commencement of the other. Along this line there are few exposures of the strata. In this belt occur the chief deposits of brown *iron ore*, for which this valley is remarkable. There would appear to be, however, no strict rule of uniformity as respects their position. A fertile tract, in which the limestone shows itself, borders this range of barrens on both sides, extending to the foot of the bounding mountains. That on the north west forms the valleys of Half Moon and Warrior Mark, while Spruce Creek valley forms the belt on the south-east. The barrens themselves consist of broken and undulating hills, separating in some places into two ranges, corresponding to the two anticlinal axes of the district, enclosing numerous hills of sand and clay, between which we occasionally meet with exposures of the lower beds of the limestone. These intervening lower hills present no uniformity. In some places the barrens embrace four ranges of hills, and in some places three. The relation of these hills to the enormous deposits of iron ore near them and among them, is as varied as their topography, though something like system is observable; thus on the north-west side of the broad synclinal axis, there is a long chain of ore banks, extending from near Bellefonte to the Little Juniata, not departing far from the line of the Nittany valley axis. The ore beds lie usually on the range of sandy hills, on their south-eastern slopes, and near their

summits, though sometimes they occur on their very tops, and again on their sides facing the north-west. The hollows between these hills also contain, occasionally, rich accumulations. These are the positions of the large ore banks of Julian, Curtin's, Hannah, Bald Eagle and Hupfington furnaces. The south-eastern anticlinal axis presents us with but one group of ore banks, namely: those attached to Pennsylvania furnace, but there are a number of other excavations in the intermediate space between the two ranges.

All the ore of this belt of country belongs to one general species, the brown or *hematitic iron* of mineralogists; it exhibits, however, an almost endless variety of structure and much diversity of composition. Some of it is earthy and compact, approaching the jaspery iron ore; some of it highly porous and cellular; some regularly stalactitic, receiving the name of *pipe ore*, while other portions occur in hollow geodes, often lined with the crystalline hematite, and occasionally filled with water. The imbedding earth is itself no less various, consisting of clays and sand of nearly every hue: brown, yellow, red and other tints, derived from the oxide of iron. The lumps of ore are lodged in these deposits in almost every conceivable manner; sometimes in isolated pieces in the clays, sometimes, in narrow layers called veins, sometimes grouped into bunches, and sometimes forming vast blocks, weighing each several tons. The chemical composition of these ores, will be specially alluded to in the final chapter of the present report, where mention will be made of our iron ores generally.

The only indication to be relied upon in seeking for the ore, is the relative abundance of its fragments upon the surface.

The Slates of F. III.

The slate ranging along the north-west side of this belt of limestone valleys displays the same features already noticed, as characterising it at the foot of Tussey's mountain.

The Sandstone Rocks of F. IV.

These form Bald Eagle, Brush, Canoe, Look, and Dunning mountains bounding this chain of limestone valleys on the north-west and west. At Milesburg, in Centre county, the strata dip steeply to the north-west, their angle being nearly seventy-five degrees. From this point south-west for some miles, the crest of Bald Eagle mountain, is high and undulating, its south-east flank containing the usual terrace. About eight miles from Bellefonte, its features change in conformity with the abrupt overturn of the rocks near the anticlinal axis. The crest and terrace of the mountain become depressed, and more irregular in their outline. The Slate F. III., rising to the verge of the terrace, and sometimes even forming a part of it, while this shelf is more frequently cut by deep ravines. These are quite conspicuous near Hannah and Bald Eagle furnaces. The Little Juniata river affords a

good display of the rocks of F. IV, in this mountain, which ranges with little deviation to a point about five miles south-west of the river. It then undergoes a remarkable alteration in its outline, the crest rising suddenly to a conspicuous height above the low, denuded terrace. A corresponding change in the attitude of the strata, explains this new feature. The rocks north-west of the axis, which for a previous distance of several miles, are inverted or overturned in their dip, here assume a less disturbed position, inclining regularly to the north-west, the massive sandstones of the mountain involved in the same derangement, assuming also their natural attitude. Throughout that part of their course, where they stand nearly vertical, or have been crushed more or less by the inversion, they have opposed a less resisting barrier to the tremendous energy of the denuding waters, which have shaped the vallies and mountain ridges of our State. Where the rocks change their posture and take a gentler dip, they presented a broader bulwark to the floods, and have, therefore, undergone a less extensive devastation. From this point to Hollidaysburg, where the great sandstone formation folds over the expiring axis of Nittany valley, the mountain preserves great uniformity of structure, its crest being high and regular, and the terrace broken as usual at given intervals by deep ravines. A slight change in the direction of the mountain, occurs a short distance north of Black's gap, opposite to which the main limestone valley terminates in a little trough shaped one, about two miles in length, produced by the scoping out by the waters escaping through this notch, of the soft middle strata of F. IV., the denudation of which usually causes only a flat shelf or terrace.

The sandstone belt F. IV., sweeping round the end of the axis in a broad knob, north of Hollidaysburg, assumes a north-east direction to form the north-west boundary of Scotch valley. At the head of this, falling into the synclinal trough, prolonged from Nittany valley, it curves suddenly back to the south-west, making the end of Canoe mountain, where it displays a prominent synclinal knob, flanked on each side like those in Kishicoquillas valley, by a broad terrace of the middle beds of the formation. From this end of Canoe mountain, the formation ranges in a regular ridge for about five miles. The Slate F. III., occupying every where its usual position at the base of the ridge. Opposite Etna furnace, the mountain exhibits a sudden and remarkable change in its strata, which are heaved by a dislocation, much to the west of their previous range, and at the same time inverted, presenting a broad irregular bulge at the commencement of the overturn. This fracture in the rocks gives rise to a very complicated structure from this point to the gap at the Juniata, a description of which could not be rendered intelligible without the aid of a map and sections. Short mountain or Canoe hill, is the regular prolongation of Lock mountain, separated from it only by the gorge at the river. From this point to the end of Lock mountain, where it folds under the synclinal axis, north of Martinsburg, the formation is regular, dipping steeply to the north-west, the upper division forming the high sharp crest of the ridge and the lower, the margin of a well defined terrace.

Curving as it passes the synclinal axis, the whole formation folds back towards the north-east, to double once more towards the south in the broad and high knob, south of Frankstown, where it folds over the anticlinal axis, which ranges from this point through Brush valley, as already described. From this point, it pursues a nearly southern course, under the name of Dunning's mountain, showing conspicuously the effects of denuding action, until it curves again at the head of the valley called Dutch Corner. The low and broken double crest of the mountain throughout this part of its range, is the result of a vertical upheaving of the rocks, and their consequent shattered condition, by which, as in the instance of the Bald Eagle mountain, the strata have been more readily affected by denuding currents than elsewhere. At the curve of the mountain at Dutch Corner, its features change; instead of presenting a double chain of knobs, one formed by the upper, the other by the lower, sandstone belts of the formation, the whole stratum doubles over a short anticlinal axis, which diverges from the centre of the valley, imparting greater height and regularity to the summit. After making a double flexure round this axis, and round the head of the synclinal basin in Dutch Corner, the mountain resumes once more a S. S. W. direction. At the most eastern part of the bend, the lower strata of the formation coalesce with the corresponding ones in Tussey's mountain opposite, thus closing up the lower end of Morrison's Cove, leaving only a narrow rugged passage between it and the next, or Snake Spring valley on the south. The mountains soon separate, the same anticlinal axis elevating the limestone in the southern part of Morrison's Cove, and lifting this rock to the surface in the adjoining valley just mentioned.

From the end of Lock mountain to the synclinal axis S. E. of Woodbury, which is a prolongation of that passing through the knob of Lock mountain, Morrison's Cove embraces two lines of elevation, and one of depression, in the strata. The axis of Snake Spring Valley, commences at Frankstown, and passing through the knob just south of it and through Brush valley, traverses the Cove, and enters Snake Spring Valley by the pass above described. The rocks on the east of this line dip east twenty-five degrees, while those on the west dip forty-five degrees to the west, and are in some places vertical.

Iron Ores.—Near the line of this axis we have a belt of barrens, composed of superficial sand and clay with iron ore, similar to that noticed in the same limestone range further to the north-east. The denudation in Morrison's Cove, having been less than in the other part of the belt, the deposits of clay and sand occupy a wider zone along its centre. Connected with Sarah and Woodbury furnaces, there are many extensive excavations for iron ore; but want of space will not permit me to describe these and the other interesting mines of this belt in detail, or do more than present a brief sketch, together with some analyses of the characteristic varieties of the ore. The ore belongs to the brown hematitic species, common in the limestone vallies, its two predominant varieties being the compact brown ore, either in large masses, or minute fragments, and a massive cellular ore of a

somewhat lighter tint. Another belt of ore deposits, occupying the other anticlinal axis of the cove, presents a greater diversity of forms.

Springfield furnace has around it several ore banks which furnish a great variety: one yielding a large supply of rich ore mingled with much sulphuret of iron; another affording a dark variety, in great abundance, containing much oxide of manganese, while another bank supplies a hard and siliceous lump ore. But besides these kinds there is an immense quantity of ore of superior quality.

The ore banks of Rebecca furnace, produce also, many sorts. One furnishing in part *pipe-ore* of the richest kind; another a compact hematite in large lumps and hollow nodules of every size and form; and another, an ore so sulphurous as to be unfit for the furnace. The analyses in chapter VII., will exhibit the usual composition of the better kinds of ore found so abundantly along this central belt in Morrison's Cove.

Snake Spring Valley, is but the northern termination of a long and rather regular valley of elevation, which south of the Raystown Branch of the Juniata, takes the name of Friend's Cove. It consists centrally, of the limestone F. II. bounded on each side by the overlying slate, ranging at the foot of Tussey's mountain on the east, and Dunning's or Evitt's mountain on the west. From the head of Snake Spring Valley, it is traversed by an anticlinal axis, on the western side of which, the limestone is sometimes nearly vertical, and is every where steeper than on the eastern. This cove or valley, has not yet been explored in detail.

Of the Valley at the base of the Allegheny Mountain.

Red and Variegated Shales, F. V.

The north-west flank of Bald Eagle mountain being generally covered throughout its lower half by a deep deposit of debris, washed from the adjoining ridges, the shales of F. V. are visible in but few exposures from Milesburg, to the Juniata river. This formation has been penetrated at a number of points in pursuit of the fossiliferous iron ore which belongs to its middle strata, and though some of the calcareous layers have been found slightly impregnated with oxide of iron, the true fossiliferous ore has not been yet discovered. Several openings have been made at Julian and Hannah Furnaces. Here the shales occupy the slope of the mountain, and where the dip is vertical, extend sometimes to its summit. The lower, more gentle acclivity of the mountain, formed by the soft shale, is usually covered with oak; the higher and steeper slope caused by the sandstone F. IV. sustains more generally pines. This order of things prevails to the point where the vertical attitude of the rocks passes into a more gentle dip, accompanied by an increased altitude of the ridge, beginning about five miles north-east of Tyrone Gap. From this point the fossiliferous ore occupies its usual position in the stratum on the north-west slope of the mountain, at a short distance from its base, its out-

crop being designated by a slight elevation. The ore varies from ten to sixteen inches in thickness. It is compact and moderately rich, and is associated with calcareous beds containing but little oxide of iron. Both the ore and the calcareous layers, are interstratified with beds of olive-colored slate, unaccompanied by any stratum of sandstone either above or below them, such as designates the ore in the Lewistown and Stone Vallies. Near Bell's furnace, the ore has been opened in several places. When mixed with the compact brown ores from the limestone belt on the south-east, a very superior iron is abundantly produced.

Formation V., attended by its belt of fossiliferous ore, maintains the same position near the foot of the mountain, until the rocks fold over the articial axis at Hollidaysburg. Here the inclination of the bed is very gentle. Hollidaysburg stands upon the ferruginous layers, in the upper part of F. V., further south from the knob of the mountain than the outcrop of the genuine seam of ore. Near Frankstown, the fossiliferous ore is met with among the olive shades of F. V. associated with a few thin calcareous and ferruginous layers, and unaccompanied by any bed of sandstone of sensible thickness. The layer of ore at this place is fourteen inches thick, and near its outcrop is of very superior quality, containing but little calcareous matter. It is smelted in the Frankstown furnace by itself and affords a large proportion of iron. The mine is on the south slope of the mountain, and one mile north-east of Frankstown.

Several exposures of a thin impure fossiliferous ore are visible in the town of Hollidaysburg; but these occur too high in the formation to be a part of the true ore bed. This ferruginous calcareous seam is associated, moreover, with a different group of rocks from those which imbed the true fossiliferous ore, as we may plainly behold, in a fine section of the strata on the Portage railroad, three-fourths of a mile above the town. At this place we witness a number of the same ferruginous calcareous seams, from one to eight inches thick, interstratified with variously colored shales, sometimes several feet in thickness, and with still thicker beds of sandstone. Some of this fossiliferous material is moderately rich in iron, while other portions are hard and superabundant in calcareous matter. After doubling over the anticlinal axis at Hollidaysburg, the ore bearing formation F. V., takes its course along the base of Brush Mountain, bordering Scotch Valley on the north-west. We have here the same condition of things as upon the north side of the axis, F. V. forming the base and lower slope of the mountain, and a low protuberance on the flank, marking the range of the fossiliferous ore. It is exposed in a number of places, though hitherto it has not been extensively opened.

The shales of F. V., folding round the end of Scotch Valley, here called the Beaver Dams, assume a south-west direction along Canoe mountain, ranging regularly as far as the dislocation north of Williamsburg, where the stratum becomes involved in the sudden inversion which affects all the rocks of the mountain, becoming concealed until the ridge terminates at the river, where the beds appear in the

most contorted and disturbed position. Here a number of excavations have been made in quest of the fossiliferous ore, but the strata are so confused and crushed that it is not traceable for any distance, appearing to divide in some cases into several thin calcareous seams, slightly impregnated with iron. It is barely possible, however, that these represent not the true fossiliferous ore, but the ferruginous and calcareous layers found at Hollidaysburg. On the north side of Canoe hill, the shales assuming their regular position, or a steep north-west inclination, the ore exists in a thin bed of porous structure, between six and eight inches thick, unaccompanied by any thick layer of sandstone. It has been opened for the adjoining furnace, but will not repay the cost of mining it.

The formation resting steeply on the flank of Lock mountain, rises high up on its north-west acclivity, and is thickly covered by fallen earth and fragments from the ridge. Ranging to the south-west, it curves round the loop or recess of Old Town run, following the recurving spur of the ridge with a gentle south-east dip. In this part of its course, the fossiliferous ore is embraced in the hills at the base of the mountain, being discoverable on the surface in numerous rich specimens. The bed itself was found exposed two and a-half miles from the head of the loop. The ore is good, though only seven inches thick. A thicker seam may exist, but such was not discovered. The ore bearing formation folds over the anticlinal axis in the Broad Knob, south of Frankstown, to follow Dunning's mountain, towards the south. This ridge having its strata vertical throughout a course of many miles, the shales, F. V., rise in this case as they usually do, high up upon its slope. At the gap, near Martha forge, they form a constituent part of the mountain, the limestone F. VI. and sandstone F. VII. lying at its base. As far south-west as Sarah furnace, the fossiliferous ore does not show itself on the surface, in consequence of this state of things, the only exposures of the strata being in M'Kee's gap at Martha forge. At this place, some of the upper shales adjacent to the limestone, are visible, but the fossiliferous ore cannot be detected by any indications on the surface, the portion of the stratum containing it being too much concealed.

Limestone F. VI., and Sandstone F. VII.

Ranging near the base of the Bald Eagle or Muncy mountain, and the ridges forming their continuation towards the south, the fossiliferous limestone and overlying sandstone usually form a more or less distinct ridge, which is sometimes, however, obliterated by denudation. The average thickness of the limestone is probably about two hundred feet, while the coarse sandstone that surmounts it, is usually not more than one-fourth of this thickness. From Milesburg to the Little Juniata, in consequence of the nearly vertical attitude of the strata, both of these formations are very obscurely exposed. They rest close under the base of the mountain, while the dark slates of F. VII. generally occupy the valley between them and the Allegheny

mountain. At Julian furnace they do not appear on the surface; but from information imparted to the proprietor, respecting the position of the limestone, it has since been reached, thus saving him the necessity of procuring a flux from the other side of the mountain.—A range of *sink holes* at the base of the ridge generally indicates the position of this limestone. It forms, however, a short ridge at the foot of the mountain, a few miles south-west of Bald Eagle furnace, continuing, with occasional interruptions, nearly to M'Cammit's forge. A few massive beds of the overlying sandstone occupy the north-west slope of this ridge, beyond which, to the north west, commence the slate of hills of F. VIII. Where the river cuts the ridge, one mile south-west of Crotzer's forge, the whole thickness of the sandstone stratum is between sixty and seventy feet.

There is a change in the attitude of these two formations, corresponding to the altered posture of all the rocks, commencing at the rise in Brush mountain, five miles south-west of Tyrone gap, their previous steep inclination to the north-west, giving place to a gentle dip, succeeded further to the south-west by an anticlinal axis, occurring at some distance from the base of the mountain. The trough in the strata, between the mountain and this anticlinal axis, embraces a synclinal ridge of the sandstone F. VII., supporting the lower dark slates of F. VII., in the vicinity of Bell's ore bank. This synclinal axis, analagous in all respects to those previously described, as traversing the Lewistown valley, contains the valuable ore banks of Bell's and Allegheny furnaces, the ore existing apparently at the former, in precisely the same geological relations before adverted to, as marking its situation north of Waynesburg, at the head of the Juniata, in Little Cove, and elsewhere. The ore itself exhibits very nearly the same structure, being dark brown and cellular, the cavities sometimes empty, sometimes filled with clay, sometimes with a loose nucleus or enclosed lump of undecomposed blue protocarbonate of iron. That of Bell's bank is frequently siliceous, though it is productive and yields a good iron. The excavation occurs one mile from the north-west base of Brush mountain. The ore bank attached to the Allegheny furnace is in the same range, about four miles remote from the furnace. This is a much larger excavation than the former. The ore is of the same varieties, embracing, however, a greater proportion of the large cellular lumps. The deepest part of the digging exposes a yellowish, porous sandstone, near the contact of F. VI. and F. VII., with ore infiltrated between its fissures. The clay deposits of this synclinal axis have been derived from the disintegration of this soft rock, which is much impregnated with iron. Near Allegheny furnace, another ore bed occurs in the clays of this trough. This consists almost entirely of *pipe-ore*, from which some large and beautiful stalactitic columns have been obtained. The ores of Allegheny furnace seem not to have been produced from the black slates at the base of F. VIII., but rather from the soft yellow ferruginous sandstone near the bottom of F. VII.

The valley between Brush and Allegheny mountains, exhibits some

change in its features, from where the anticlinal axis shows itself.— From M'Cammit's forge or Tyrone Gap, the valley expands by a change in the direction of both mountains, changing from a breadth of two or three miles to one of six or seven miles. It assumes very nearly the character which it has at its other end, near the Susquehanna. Pleasant valley and Logan or Tuckahoe valley, occupy a part of this broad interval. The anticlinal axis elevating F. IV. and F. VII., forms a range of hills or ridges, separated from the Brush mountain by a little valley, and from the slate hills to the north-west, by another; this axis does not extend south-west of Allegheny furnace. Beyond this, the mountains fold over the other or main anticlinal axis of the mountain, at Hollidaysburg, and displays a symetrical and beautiful feature in the topography.

From Allegheny furnace, the belt of hills composed of the limestone and overlying sandstone, after passing Duncanville, sweep in a regular curve south of Hollidaysburg, and take a direction along the south-east side of Brush mountain. Formation VI. is here in its middle beds a pure blue limestone, but partakes near its contact with F. V. and F. VII., of the aluminous character of the former, and the sandy nature of the latter. The limestone, together with the sandstone which it supports, preserve their position in a prominent ridge throughout their course along the north-west side of Scotch valley. About five miles from the river, near the head of this synclinal basin, these strata sweep round to pursue the base of Canoe mountain, in its course to the south-west. Like all the strata near them, they are implicated in the inversion or overturn of that ridge, which we have already more than once alluded to, and appear much contorted at the gap of the Juniata. This disturbed condition of things prevails for some distance along the western side of Lock mountain, until approaching the "loop" the formations become more regular, and curving round at the head of this synclinal basin, they range towards the knob south of Frankstown. Here, as in the case of F. IV., beneath them, they fold over the anticlinal axis, to pursue their course near the base of Dunning's mountain. These formations compose a regular chain of hills encircling the isolated tract of F. VIII., in the centre of this basin of Scotch valley and Old Town Run. The limestone along Lock mountain, is for some distance blended with the slope of the ridge; but where the nearly vertical dip is replaced by a gentle one, a short distance south-west of the river, then the limestone and overlying sandstone leave the foot of the mountain, and form, as usual, a ridge to themselves.

The anticlinal axis elevating the high knob south of Frankstown, overlapping or passing the anticlinal axis of Brush mountain, north of Hollidaysburg, the two form between them a small synclinal trough, in the sandstone F. VII., immediately at Frankstown, in the middle of which, occurs a shallow belt of F. VIII. This collapsed axis extends but two miles north-east of the town, terminating in a little contortion of the limestone, which soon disappears in the general south-east dip of that formation, in Turkey ridge, along the margin of Scotch valley.

In the little belt of slate referred to, should occur the band of iron ore characteristic of the lower part of that formation in other districts, but it is probable that the calcareous and ferruginous layers of the formation, have either been washed away, or did not enter originally as a part of the stratum. The fine grained argillaceous sandstone at the bottom of F. VII., to which we ascribe the ore banks of Allegheny furnace, appears in this neighborhood to be very thin, and almost vanishes as we proceed to the south-west.

Olive Slate F. VIII.

The belt of dark slate, together with the overlying rocks of F. IX. lying at the base of the Allegheny mountain, show a tract of gently rounded hills, divided by irregular ravines. Sometimes these hills form two ranges, separated by somewhat regular hollows; but these uniform features in the topography are not of great extent. The valley of the Bald Eagle creek, at Milesburg, formed by the floods escaping through the gap, is a level plane, for some distance, enclosed between these slate hills and the Bald Eagle mountain. Towards the south-west, the slate hills encroach, and leave but a narrow valley between them and the ridge. This occurs at Hannah furnace, two miles south-west of which, the slate hills lie at the very base of the mountain, in consequence, no doubt, of the vertical attitude of all the strata. Beyond this to the south-west, they again recede, leaving a little valley drained by the head waters of the Little Juniata. A section crossing the slate, and the overlying beds of F. IX., along Wallace's run, exhibits a dip of about forty degrees to the north-west. Further to the south-west, the inclination of the beds is occasionally steeper; but the uptilting of the strata which has brought the slate near the foot of the mountain, does not so much affect it as the other strata immediately south-east, which have passed into a nearly perpendicular attitude. Near Hannah furnace, ten miles from the gap of the Little Juniata, the hills of F. VIII. and F. IX. are higher and bolder than usual. They continue thus until south-west of Bald Eagle furnace, where they recede from the mountain, leaving Logan's valley between. They then become lower, and present gentler slopes. These features extend along Logan and Pleasant valleys, the formation still preserving a regular dip to the south-west, until the whole sweeps over the subsiding anticlinal axis of Brush mountain, four miles south-west of Hollidaysburg. Opposite Blair's gap, the rocks all dip at a moderate angle to the north-west. Near Newrey, we have an anticlinal elevation in the valley between Dunning's mountain and the Allegheny; leaving a trough in the rocks at the base of the former ridge, in the continuation of the synclinal axis of Frankstown. The black slate at the bottom of F. VIII., extends in a narrow belt along this trough to Frankstown, where it disappears.

As before stated, a large tract of F. VIII., occupies the middle of the basin of Scotch Valley and Old Town run. The highest beds of

the formation left in the centre of this valley, are the grey sandstones and dark olive slates of the upper portion of the stratum.

From Newrey southwest, the formation resumes its regular W. N. W. dip, at an angle generally exceeding thirty degrees. The belt has not been yet traced further in that direction than Sarah furnace, in Bedford county. Minute and careful observations were made, with a view to detect the existence of a vein of iron ore analagous to that found in the lower portion of the stratum in Lewistown valley and Little Cove, but hitherto without success. The absence of a visible outcrop of the ore may arise, in part from the non appearance of the narrow trough-like ridges of the sandstone F. VII. which elsewhere sustains the belt of the ore, leaving part of the slate under circumstances well calculated to reveal the bed. The axes of elevation producing that peculiar feature in the topography, are here wanting.

Red Sandstone F. IX.

The red argillaceous sandstones and red slates constituting F. IX. form a belt of rounded and denuded hills, skirting the base of the Allegheny mountain; the whole south-eastern slope of which likewise embraces these rocks, which are only surmounted by the sandstone strata of F. X., near the summit of the ridge. This order of things prevails along the whole escarpment of the mountain, except in the neighborhood of the Blue Knob, the structure of which will be presently explained. From Milesburg for a considerable distance south-west, the hills composed of F. IX., are rather elevated and steep, but as we advance they subside, while the spurs jutting forward from the flank of the Allegheny become relatively more prominent. Approaching Hollidaysburg, the hills at the base of the mountain, consisting of F. VIII. and the lower rocks of F. IX., form a belt presenting regularly rounded and undulating slopes, evincing the enormous amount of denudation to which they have been exposed. The table land of the Allegheny mountain, lying beyond them to the north-west, shows in the same neighborhood, a great number of deep transverse vallies, or long ravines extending down its flank, which have obviously given passage to the retreating floods which scooped the great valley at its base. The promontaries or spurs embraced between these ravines, stand forward from the flank like enormous buttresses or ramparts.

The general dip of the strata at the base, or in the flank of the Allegheny mountain, is from fifteen to thirteen degrees towards the north-west, but at the Blue Knob this state of things is interrupted. An anticlinal axis, ranging immediately at the base of the Allegheny mountain, a portion of the strata south-east of this line, have a gentle dip to the south-east, meeting the north-western dipping beds of the valley between Blue Knob and Dunning's mountain, to form a synclinal trough under the Blue Knob itself. The strata of Blue Knob reposing thus in a basin have escaped the denudation which has removed the more exposed and crushed portion of the formation overlying the anticlinal axis; thus causing a valley between it and the mountain.

This structure extends as far as Bob's creek, where the flat anticlinal axis passing Blue knob begins to disappear.

Throughout the long belt here briefly sketched, Fs. VIII. and IX. exhibit great uniformity as respects their composition. The calcareous or cement beds so conspicuous in the lower part of F. VIII., along the valley of the Susquehanna as far as the mouth of Bald Eagle creek, diminish, and almost disappear when we pass to the south-west of Milesburg, and are represented by only a few dark calcareous bands containing sulphuret of iron, and occupying the black slates near the base of the stratum.

Much search was made with a view to discover if the curious red stratified ore which belongs to the lower part of F. IX., at Larry's creek and Pine creek, near the base of the Allegheny mountain, extends to the south-west, but every effort to trace it beyond the neighborhood of Farrandsville, has proved ineffectual.

CHAPTER IV.

Geology of the District north of the Allegheny Mountains, including Lycoming, Clinton, and Tioga counties.

In Tioga, Lycoming, and Clinton counties, our explorations were principally confined to the less inhabited sections lying north of the southern base of the Allegheny mountain. As far as the nature of country would permit, all the coal beds were examined, and their extent ascertained and delineated on the State map. The whole of the coal in this section of the State would seem to be confined to four narrow basins, traversing these northern counties in an E. N. E. and W. S. W. direction, parallel to the range of the Allegheny mountain. The coal within these basins is, however, not always continuous over large areas, but frequently occurs in isolated patches, capping the summits of the higher knobs of the country. As far as we have yet traced them, these basins will be separately described, taking them up in succession from the south-east to the north-west, and following each from the north-east towards the south-west. The general and local geological maps, with their accompanying sections and drawings, to appear with my final report, will represent fully the range, structure, and contents of these several basins and detached tracts of coal measures. It is hoped, however, that the following partial details may be useful without the aid of those important illustrations.

The Allegheny mountain, pursuing a nearly east and west direction through Lycoming county, consists, at its southern base, of the slaty rocks of F. VIII., overlaid by the red shales and sandstones of F. IX. Denuding floods, acting upon these relatively soft materials, have imparted a gently rounded and undulating contour to the surface. Immediately upon them rests the sandstone formation, F. X. of our series, which, by its greater hardness has presented a great barrier to the waters, imparting bolder features and steeper slopes. This rock forms the main escarpment on the south of the Allegheny ridge; in its whole range across the State. The still harder and coarser rocks of F. XII., sometimes capping the mountain, give to it yet stronger features.

Nearly every where along the southern flank of the mountain the dip is northward, or towards its base; continuing thus for some distance, it then changes to the south, and forms a trough in the strata, in the higher tracts of which, we find the southern belt of coal measures. The Allegheny ridge, properly so called, usually embraces along its immediate summit, no stratum higher than F. X. Occasionally, however, it is capped by the coarse conglomerate of F. XII., embracing, in places, a characteristic "brown rock," and in a few knobs, the still higher beds of the coal series, to which the brown rock is an important index. Coal was discovered, and opened during the last summer, on the Allegheny mountain, at a point where the summit, is sufficiently elevated, to embrace all the shale here enumerated. The locality is about eighteen miles from Williamsport, on the old State road, between Newbury and Wellsboro'. Near the base of the mountain were found loose pieces of slaty sandstone characteristic of F. X. Above these rocks, which have a perpendicular thickness of about seven hundred feet, the ridge assumes a more gentle slope, and the soil presents evidence of being derived from the red shales of F. XI. This red shale is probably not more than thirty or forty feet in thickness. It is occasionally very ponderous and highly ferruginous, and shows indications of a bed of valuable *iron ore*, identical, probably, with one discovered in other places. Indeed, ore is said to have been found here. Overlying the red shale occurs the conglomerate, and loose pieces of other portions of F. XII. Its aspect is that of a white siliceous sandstone, imbedding small and scattered pebbles of white quartz. It is nowhere visible in place, and we can only judge of its position and thickness, by the loose fragments. It is probably about seventy-five feet thick. Above it occur no rocks in place; the only strata ascertained, being those developed in the excavations for coal. The following section exhibits the order of things from the top of the highest bench on the mountain, down to the conglomerate:

1st. Coarse micaceous sandstone, containing many vegetable organic remains.

2d. Fireclay, 0 feet, 5 inches.

3d. Coal seam consisting of coal, 5

“ “ fireclay, 12

“ “ coal, 3 “ 2

“ “ shale, 4

“ “ coal, 1 “ 8

“ “ fireclay, 3

“ “ coal, 9

4. Fireclay, 6 0

5. Dark fireclay containing *fucoïdes*.

6. Coal seam consisting of coal, 1

“ “ shale, 4

“ “ coal, 1

“ “ shale, 2 4

“ “ coal, 1 3

“ “ shale, 1

“ “ coal, 11

7. Black slate containing vegetable fossils, *fucoïdes*, *lepidodendron*, *sigilaria*, *equisetacea*.

8. Brown sandstone rock.

9. Conglomerate.

This section is compiled from the measurements in several adjacent shafts, in which, it must be observed, the quality and thickness are not every where strictly the same. The main or upper coal seam, extends for more than a mile along a bench or terrace, which serves if carefully noticed, to mark its position. This flat, however, is narrow, the ground sloping rapidly away on both sides down to the conglomerate. Its course is rather irregularly northwards for nearly a mile, when it turns east, and gradually falls away towards Hogeland's run. The southern dip of the coal-measures, soon causes all the coal to disappear as we advance to the north, the red shale of F. XI. coming to the surface and marking the limit of the basin. Beyond these rise the sandstones of F. X. succeeded by the red shales and sandstones of F. IX. the latter constituting the principal part of the hill south of Larry's Creek, and the whole of those lying north of it, in the tract of country known as the Cogenhouse settlement. Excavations were made among the red shales of F. XI. north of the coal, in search of the iron ore which often occurs in this stratum. The shale in some places is exceedingly heavy, containing much oxide of iron; its color is also similar to that of some ores found in the formation, and might readily deceive an inexperienced observer into the belief of its being a productive iron ore. Further explorations, however, will probably result in the development of such in this vicinity.

Eastward the mountain is deeply intersected by the narrow valley of Hogeland's run, to the east of which, on Bope's mountain, exist fair indications of the coal measures, some pieces of the conglomerate being observed on the highest knobs, in a situation indicating the pos-

sibility of coal near the summits. It cannot, however, occupy an extensive surface, though if found, it would derive value from its proximity to the rail road running through the valley of Lycoming creek.

During the season which has closed, no examinations were undertaken further to the eastward along this basin; but coal is known to occur about Bear creek, and Little Bear creek, belonging, no doubt, to the same range. Its examination was deferred to the next season. The dips of the strata along Lycoming creek, indicate that this basin crosses the valley of that stream only a little above the mouth of Trout Spring run.

Towards the west, the mountain falls away to a branch of Larry's creek, called the Roaring Branch, beyond which it rises again to about the same elevation, presenting a flat area of more than a mile square on its summit. The conglomerate rock seems to lie about forty feet below the highest part of the hill, the outline of which is such as to imply the existence of the coal measures. A careful inspection of the surface was made, but no excavations undertaken. Further westward, the hills continue of nearly the same height, but examinations carried on in that quarter about the sources of the western branch of Larry's creek, did not result in the discovery of any coal. A few knobs, each containing a few acres, were occasionally found, possibly high enough to embrace one bed of coal, but they were deemed not of sufficient importance to justify any systematic excavations.

Explorations to some extent were made several years ago, for coal on some of these hills, but all the shafts were dug in the strata below the coal measures, and the highest ground lying in the centre of the trough, were entirely neglected. Excavations more judiciously undertaken, may possibly bring a better coal to light.

The geological map will show the range of the basin from Hogeland's run, across the sources of the different tributaries of Larry's creek, and thence across Pine creek, near the mouth of the First Fork, while the section along Pine creek will exhibit the position of the trough on that stream, and where the coal is to be sought for. In the high tongue of land between the First Fork and Big Pine creek, the hills have considerable elevation. Near the level of the stream, F. IX. just makes its appearance, being immediately succeeded by F. X., which occupies between eight hundred and nine hundred feet of the hills. Above this, the slopes become more gentle, the soil indicating the presence of the red shale. Here a bench in the side of the hill occurs, containing a white sandstone, referrible to F. XII. The rock is without pebbles, being a remarkably white and pure sandstone, readily disintegrating and furnishing a sand that would be well adapted for the manufacture of glass. To this succeeds another band of red shale, and in a high knoll we find another white sandstone similar to that just mentioned, above which are beds of *olive colored slates and*

argillaceous sandstone; holding nearly the position of the lower seam of coal, the existence of which, however, is not indicated. This is about the true place for the coal, if it occurs at all in the region. I would suggest to the owners of lands on both sides of Pine creek, lying a little above or below the mouth of the First Fork, to search for it above the white sandstone of F. XII. in the highest knobs. The lands occupying the head of the north branch of Ramsey's run, being near the centre of this basin, promise best—other things the same, to reward research for coal. Excavations have been made a little above the mouth of the First Fork, by those not familiar with the stratification of the region in a position *below* the rocks of F. XII., thin layers of coaly matter here presenting themselves in F. X. The quantity of dark slate, similar to that of the coal measures, is considerable and it is said, indeed, that a coal seam eight inches thick, was found. The exploration was, however, abandoned; and this will always be the case, when the search for coal is undertaken so far down in the series. On the west side of Pine creek, coal was once worked, for an old furnace near the Jersey Shore and Coudersport road. This tract will be explored during the coming season, though from all that we have this year learned, it cannot prove extensive or of much productivity.

The rocks along the Susquehanna river, are the argillaceous sandstones forming the thick bands at the alternation of F. IX. and F. X. dipping at a considerable angle to the north-west. At the mouth of Lick run, these give place to F. X., having its usual characters of a brown slaty sandstone, but containing a few bands of a siliceous conglomerate, somewhat like F. XII., though darker. Above this sandstone lies the red shale of F. XI. in two separate strata, alternating with a grey sandstone, referrible either to F. X. or F. XII. The lowest of these red shales, is a bed sixty-five feet in thickness, containing two seams of *iron ore*, one only about six inches thick, the other twenty feet above it, being about ten inches. The ore is apparently good, but probably, not sufficiently abundant to be valuable.

A similar ore has been discovered on Queen's run, a mile and a-half north-east of the Queen's run mines, where it promises a greater quantity. Between the two seams of ore, occur buff colored and red shales. Overlying this red shale is a thick stratum of grey sandstone, analogous to that of F. X. about two hundred and fifty feet thick. This supports another thinner bed of red shale of F. XI. At the mouth of Queen's run, F. X. contains a seam of fire-clay four or five feet thick, which is a little too sandy, but may be worth working, if mixed with a more argillaceous variety. At the mines on Lick run, the strata have been bored from the highest ground down to the upper bed of the red shale. At different points, where this was done, the strata do not precisely correspond. One of the most important of the beds, a seam of coal is absent over a considerable extent, owing to a dislocation in the strata, or other causes not yet ascertained. In one of the knobs

where the position of the coal appears to be represented by slate and sandstone, we have the following section :

Soil,	1 foot 2 inches.
Rotten coal, which, when under sufficient cover, is usually five or six feet,	1 " 6 "
Soft white clay, in other places worked as a fire clay,	6 " 9 "
Brown slate,	5 " 0 "
In this position should occur a coal seam six feet thick, containing sixteen inches of slate, nineteen feet below the brown slate, but it is absent	
Dark slates and flaggy sandstone,	76 " 5 "
Coal,	2 " 4 "
Dark slate,	9 " 7 "
Coal,	3½ to 5 " 0 "

The above section embraces the lowest coal bed of the basin. It is this seam which is at present principally mined by the Farrandsville company for their furnace, and other works. About fifty cubic yards are mined daily, costing fifty-seven cents per yard for the mining, the small coal not being counted. The coal is coked at the mouth of the mine, being transferred immediately from the cars to large heaps, where it undergoes the coking process without the aid of ovens. It is then sent by an inclined plane and rail road to the furnace at the base of the mountain. The second coal seam in the ascending order is not worked, the coal being impure; but the third, were the ground is sufficiently elevated to embrace it, has been wrought to some extent, yielding a better coal than either of the other two. It is now, however, nearly exhausted. This upper coal seam, lying usually near the surface of the highest ground, has generally an unscind roof, which unfits it to be mined. It measures commonly six feet in thickness. It is now removed to expose the fireclay which lies immediately beneath it, found to be of superior quality for the manufacture of fire brick.— This fireclay, from six to seven feet thick, is destitute of grit, and furnishes an admirable fire brick. Under it lies a bed of shale, containing a layer of *nodular iron ore* of no great purity or richness.

Beneath the lowest bed of coal, slaty sandstone and shales occupy a thickness of forty-six and a-half feet, succeeded by twenty-five feet of red shales, this by upwards of two hundred feet of grey sandstone, and this again by the lower bed of red shale. It is very remarkable that we nowhere find the rocks occupying the position of F. XII., possessing the conglomerate character, while in every other neighborhood, in the same basin, as at the first fork of Pine creek and on the Tangascootac, as we shall show hereafter, this rock exists in its true type and features.

At Queen's run the same beds of coal and fire-clay occur which we see at Farrandsville, with this difference, that the uppermost coal seam is here under an ample covering and ranges over a tolerably extensive surface, being the only bed at present mined. Its thickness varies from five feet to three feet nine inches. The coal is superior, and finds a ready market along the Susquehanna.

The *fireclay* at this place is occasionally eight feet thick. A bed of coal about four and a-half feet thick occurs not far beneath it. This does not appear in the coal measures above Farrandsville. The other beds in the series are supposed to occur here, though their existence has not been positively ascertained. At the mouth of Queen's run fire bricks are made to a moderate amount.

They are manufactured at Farrandsville on a more extensive scale: about six thousand nine inch bricks being made every week, commanding about forty-five dollars per hundred. These are at present principally used on the spot for the furnace and other works. The furnace now in operation is built of stone, lined with the fire brick; it is fifty-four feet high. The diameter of the boshes was originally seventeen feet, but was lately reduced to thirteen. A powerful steam engine, having ten boilers, and estimated at one hundred and seventy horse power, when all are in action, propels the blast. From the description given of the coal measures of Farrandsville, it would appear that they furnish neither iron ore or limestone. The ore used in this large and ably constructed furnace, is brought from Montour's ridge, in Columbia county, being the fossiliferous ore of F. V. An inferior species is also procured on Larry's creek from the lower beds of F. IX., the former is transported about one hundred miles, the latter twenty-three miles. The limestone is that of F. II., from Nittany valley. The proportion of the materials employed in making one ton of cast iron, in October last, were as follows:

Coke,	6,500 hogsheads,	2,900 tons.
Fossiliferous ore,	3,200 "	1,428 "
Larry creek ore,	3,500 "	1,562 "
Limestone,	4,500 "	2,009 "

After the furnace had been in blast some time, starting in the month of October last, the cast iron produced was of a superior quality as a foundry iron, the yield being about fifty tons per week.

Passing to west side of the Susquehanna, the coal measures next appear on the Allegheny mountain, on the southern side of the Tangascootac creek. This stream runs nearly centrally along the basin for five miles, with a margin of comparatively broad and regular bottom lands on each side. Owing to the greater amount of denudation in the lower part of the valley, the coal measures do not there occur; but higher up they expand over a considerable extent of country, and acquire a thickness of several hundred feet. The growth near the south fork is open, consisting of fine hard wood and scattering white pines, and the surface changes from the steep mountain acclivities, seem nearer the river to gently rolling hills and extensive plains. The rocks along the valley of the Susquehanna for about six miles, belong exclusively to F. X. At the mouth of the creek, this formation rises nearly to the top of the Allegheny mountain, and caps the hill on the north side of the stream. The first appearance of F. XII., is where it covers the eastern extremity of the Allegheny mountain. Tracing it westward, it gradually comes in at a greater distance below the summit, until, three miles from the river, the coal measures occupy the

mountain top, and the white, pebbly sandstone of F. XII. proper, lies under the summit, and crops out high up on the southern side. The hills on the northern side of the Tangascootac, do not reach the elevation of the Allegheny mountain, until we recede several miles, when a change of the dip to the south brings up the lower rocks. Along the northern side of the creek, the knobs are capped by F. XII. as far up the valley as the Forks. A little below this, the coal measures first appear on the north side of the stream, and finally further towards the west, occupy all the high ground between the heads of the two forks, but no coal occurs to the north of the North Fork, the hills then being capped by the conglomerate. The most eastern coal beds opened, are south of the First Fork, at an elevation of about 530 feet above the stream, which, in a course of $2\frac{1}{2}$ miles to its mouth, descends thirty feet. The upper bed lies beneath a thick stratum of brown sandstone. It appears to be four feet thick, but at some distance in from the crop, a fault causes it locally to be only two feet. The quality of this coal is excellent. It is underlaid by a bed of good fire-clay. There occur about thirty-five feet of other strata, covering this bed over an area of perhaps fifty acres. Another coal seam, somewhat slaty, three feet in thickness, lies about thirty feet lower down, at no great distance under which is F. XII., forming a stratum nearly 100 feet in depth. This rock is here a fine sandstone, containing white pebbles, and disintegrates into a fine sand, well adapted for making glass. The next openings are on the south side of the creek, two miles above the Forks. The upper occurs near the top of the hill. It is four feet thick, including some small seams of slate and fire-clay. Over it lies a soft and very tenacious slate clay, four feet thick. The coal is good; it breaks into rectangular pieces, and contains much mineral charcoal, occasionally in seams nearly half an inch in thickness, showing the fibrous structure of the coal vegetation. It is beautifully marked by thin alternating laminae of dull and splendid glance coal. A bed, supposed to be the same, has been opened at a lower level in a north-western direction, that being the course of the dip. At this latter place, its total thickness is four or five feet, including one foot of dividing fire-clay. Between twenty and thirty feet under this, occurs another coal seam, not well exposed, but apparently two feet thick; upon it rests two feet of fire-clay, and over that one foot of black slate, surmounted by more than ten feet of blue slate. The rocks underneath the coal, are entirely concealed, but the conglomerate cannot be far below. On the southern side of the Allegheny mountain, there are two small benches near the summit, at some height above the steep slope, caused by the conglomerate. The lower of these contains the "brown rock," while the upper one, probably, embraces a bed of coal. The hills north of the North Fork constitute the northern margin of this coal basin. They are higher than the hills around, being capped by the conglomerate. Between the north and south forks, coal measures extend through the hills for some distance. Indications of iron ore present themselves in F. XI., in a ravine, two miles above the Forks. Between five and six miles from

the mouth, the coal measures are within seventy-five feet of the beds of the streams, the hills rising about 250 feet higher. Further westward, the surface becomes smoother, and the extent of country embracing the coal measures, much greater; but the close of the autumn confined our investigations in this basin, to the neighborhoods already described. The distance across the basin, from the Allegheny mountain to the hills north of the North Fork, is apparently about five miles, but the actual area of the coal is more circumscribed, owing to the numerous vallies of denudation. In the district hitherto explored, the indications of iron ore among the coal measures, are unpromising.

This basin is prolonged, no doubt, across the head streams of Beach creek, and embraces the coal measures at Snow Shoe and Phillipsburg.

Though the eastern extremity of this basin has not been yet explored, we have ascertained with tolerable certainty, that it crosses the Loyalsock, near the mouth of Plunkett's creek. The rocks opposite the mouth of Mill creek, the first large stream above the mouth of Plunkett's creek and along the whole extent of that stream, dip gently to the S. S. E. The conglomerate capping the hills may be traced for miles along their summits. At the very head of Mill creek, the lower beds of F. X. replace it on the hill tops; and below the mouth of that stream on the other side of the Loyalsock, F. IX., rises two hundred feet in the hill, the rest consisting of the flaggy brown sandstones of F. X. In the latter rock occur thin bands of a poor *arenaceous limestone*, hardly rich enough in lime to be of any value. It assumes a singularly pitted or worm-eaten surface from atmospheric action. It is sometimes four feet thick. On the top of the hill above referred to, at an elevation of about one thousand feet above the stream, occurs the conglomerate, apparently about forty feet thick, dipping S. S. E. The summits along the creek were minutely explored, from Mill creek to Lick creek, a tributary of the little Loyalsock, without the discovery of any thing of economical importance.

The topography of this part of the State map is exceedingly erroneous.

A remarkably abrupt anticlinal axis exposing the red sandstones of F. IX., on the stream next west of Lick creek, (another mill creek,) was traced in a west by south direction, crossing Pleasant stream, Lycoming creek, half a mile above the mouth of Pleasant stream and Pine creek, six miles above the mouth of the First Fork, beyond which it deflects a little more to the south, being the great axis separating the Snow Shoe from the Karthaus basins. Nowhere does it exhibit dips so great, as along the waters of the Loyalsock.

The considerable angle at which the rocks dip north of the little Loyalsock, causes nearly the whole thickness of F. IX. to crop out in one hill, though its perpendicular depth is about one thousand feet. The olive and greenish slates of the underlying strata at the alternation of Fs. VIII. and IX. also appear. They have been erroneously fancied to contain *copper ore*. Formation VIII. itself, comes to the surface near the confluence of Mill creek and Lick creek, where it includes

a thin bed of *fossiliferous limestone* of good quality for making lime. Near the limestone, rises a brine spring, the water of which furnishes a blackish sediment, by evaporation.

The bottom lands of the Loyalsock are wider than those on most of the other streams in the northern counties, and contain many good farms. The neighboring hills are precipitous and rocky and remarkable for the distinct features of the *benches* along their sides. Their height varies from a few hundred to a thousand feet; one of them proved to be nine hundred and eighty-eight feet by measurement. In this hill, which is a mile above the mouth of Elk creek on the north side, the strata as far as ascertained, are as follows. For the first thirty feet above the stream, red shales of F. IX. Upon the red shales a blue sandstone. Above this occur flaggy argillaceous sandstones, somewhat reddish, but more commonly blue and gray. The flat loose pieces of this rock conceal most of the lower beds, resting on the side of the hill, although it slopes at an angle of nearly seventy degrees. A somewhat reddish and heterogeneous calcareous rock, in large blocks has fallen a short way down to the water's edge. It is an indifferent limestone, probably unfit for use. At the height of five hundred and sixty-eight feet, occurs a bold bench or perpendicular cliff, formed by a bed of coarse white sandstone and conglomerate, about eighty feet thick, embracing a curious variety of white shale, one foot in thickness. Receding from this escarpment, occurs a shelf or terrace of very gentle slope, from which the hill rises by a steep and regular acclivity to the very summit, which is covered with scattered pieces of coarse conglomerate. This hill and the adjoining rivulets were closely examined, and a few excavations were made without discovering any trace of either iron ore or coal: which latter ought to have presented itself, had the bench described been formed by the conglomerate of F. XII. A band of red shale near the summit, belongs probably to F. XI. and may possibly contain some iron ore. The summit of this hill is a broad flat, used as a pasture, and the only artificial enclosure required for the cattle, is a single bar put across a narrow passage between two rocks.

On the south of Loyalsock, opposite the last hill, a bench exists apparently on a level with the top of this, while a knob forty or fifty feet high rises above it, composed of sandstone and conglomerate.— Under this last bed, is a thin seam of coal, one foot thick, overlaid by a foot of slaty cannel coal, and resting on a floor of black bituminous shale. The same band of coal was readily discovered in other places, at the base of similar knobs in the neighborhood. No iron ore was found. The coarse conglomerate occupies only the very highest knobs. The stratification here described, belongs to nearly all the hills lying on this creek.

Elk Lake is incorrectly placed upon the map; it should be five miles further west, being by the scale of the map one inch out of its true position. The country around Elk creek, consists of Fs. IX. and X. Hogeland's branch traverses the red shales of F. IX., throughout its whole course; it is a rapid stream, descending by a series of water

falls, from twenty to forty feet high, over the harder sandstone shelves, in the red shale. The scenery at some of these waterfalls, is wild and picturesque in a high degree.

Near the top of the hills around the head of Hogeland's branch, we find a stratum of poor bluish limestone one foot thick, and among the red shale 200 feet lower down, two others belonging to the alternations of Fs. IX. and X. A mile or two east of Hogeland's branch, many loose pieces of the conglomerate are scattered about in large boulders, between the head of that stream and the forks of Loyalsock. The rock is valued by the inhabitants for making mill stones. A knowledge of the stratum from whence they are derived, would prove a guide in seeking for the coal measures.

On the highest parts of Bennett's ridge, at the head of Plunkett's creek, it lies in place dipping N. N. W. four degrees, and under it we find a bed of the red shale of F. XI. It was traced for several miles near the heads of Pleasant stream and Plunkett's creek. At two or three miles below the head of Wallace's run; though the ridge is very high it does not occur. Bennett's ridge runs north-east through Elkland township, south of Pleasant stream: The ridge between Pleasant stream and Rocky run, contains only the lower rocks of F. X. This is about ten miles above Ralston. Between five and seven miles east of Ralston, the conglomerate is well exposed, capping the hills and forming an abrupt or sometimes overhanging wall, twenty-five or thirty feet high, full of dark passages and deep holes. It is not practicable to ascertain the existence of any bed of iron ore which may occur beneath this rock, without a considerable amount of digging. Approaching Ralston, the conglomerate gradually descends lower into the hills, which from the deepening of the valley of the run, has an elevation of at least 1,000 feet above its bed.

Ralston.

The next place of importance to describe, is Ralston, at the mouth of Stony or Rocky run, on Lycoming creek, twenty-six miles above Williamsport, at the present termination of the Williamsport and Elmira rail road. The hills, which are about one thousand feet high, contain, at their base, the red rocks of F. X., surmounted by the conglomeritic limestone. The centre of the coal basin crosses Lycoming creek, near the mouth of Dutchman's run, one mile above Rocky run. The anticlinal axis, causing the southern margin of this basin, crosses near the mouth of Pleasant stream, while the other axis, bounding it on the north, passes near the mouth of Roaring creek. The hills, including the coal measures, occupy a range of country east and west, nearly ten miles in length; but the coal is not continuous over all this extent, being interrupted by deep vallies of denudation. The principal localities of the coal are on a branch of Rocky run, between that stream and Dutchman's run, on Red run, the other side of Lycoming creek, and on Frozen run, near Astonville. From Ralston, a wagon road, at a grade of one foot elevation

to the road, ascends three miles to the mines. The height of the coal above the creek at Ralston is about eight hundred and seventy-five feet, while Ralston itself lies eight hundred and eight feet above the tide. On Dutchman's run, a remarkable slide in the face of the hill has laid bare F's. X. XI., and XII. On the road leading to the mines, and below the conglomerate, in a bed of dark shale, there is a valuable band of *iron ore*, lying only four feet beneath the rock, from which it is separated by a layer of brown shale. The bed of ore has not been fully exposed; it promises to be about six feet thick. The ore occurs in irregular knotty lumps, closely bedded in a soft reddish and white shale. It forms about one-half of the stratum, and consists of nearly a white crystalline protocarbonate of iron, somewhat resembling a fine grained sandstone. This is apt to be encrusted with the brown or red oxide. These balls are very solid and heavy, becoming more massive as we penetrate deeper in from the crop. In the other half of the bed, which is principally shale, occur scattered balls of the same ore, of a blotched red and white appearance. This ore is admirably suited for the manufacture of foundry iron. I shall present its chemical composition, when describing it as it occurs on Frozen run, where it is converted into iron. It is contemplated to build a furnace, for smelting this ore, on Rocky run.

The conglomerate and sandstone stratum, of F. XII., varies from forty-five to one hundred and fifty feet in thickness; the top of this rock is marked by a terrace, gently receding from the front of the hill to an abrupt slope, formed by a bed of white sandstone, about sixty feet in thickness. Between these two sandstone beds we find a seam of rather slaty coal, from eighteen to thirty inches thick, underlain by thirty inches of slate. Over the sandstone occurs another bed of coal, six feet thick, but not of superior quality, the lower part of it consisting of slaty cannel coal, and the rest being rather hard. It includes two bands of slate, one eight inches, the other near the bottom, three inches thick.

Another coal seam, between two feet six inches, and two feet ten inches thick, occurs seven and a-half feet above the former. It contains three inches of slate near the middle, but supplies an excellent coal for coking, and is much superior to the thicker seam beneath it. Above this coal we find a bed of shale, containing large nodular balls of *iron ore*, the quantity of which has not yet been ascertained; and a little higher, another seam of coal one foot in thickness. Next occur seventeen feet of sandstone, and then a bed of slate, containing balls of good *iron ore*, in considerable abundance. It is thought that this layer may furnish three feet of iron ore. Still ascending, we find eighty feet of brown sandstone, then a fireclay two and a-half feet, and a seam of coal one foot thick, blue slate three feet, brownish, and then white sandstone forty feet, and above this a bed of coal, never fully opened, but stated to be four feet thick, presenting a good appearance at its outcrop. Crowning the highest part of the hill occurs a bed of conglomerate, sixty feet in thickness, less coarse than that of F. XII. The dip of these strata, at the mines on Rocky run, is gently west-

ward on Dutchman's run; on the opposite side it is towards the E. S. E., while a few miles further up the main branch of Rocky run, it is toward to the north-west about four degrees.

A somewhat curious feature in this hill, are the swamps occurring on its very summit; the largest occupying several acres, entirely destitute of timber, and containing a deposit of *peat*, at least fifteen feet in depth. A rare tree, the *rowan tree* or *witch hazel*, occurs on the borders of these swamps.

On Red run the strata are nearly the same as at Ralston. Beneath the conglomerate, the shale containing the iron ore is thirty-four feet thick, and underneath that is a sandstone one hundred feet, succeeded by another bed of red shale fifty feet in thickness. These two red shales correspond with those at Farrandville, already described, excepting that the iron ore occurs at the latter place in the lower bed.

Frozen run enters Lycoming creek on the west side, below Rocky run. At a spot called Astonville or Oaksville, a furnace is in operation smelting the ore found in the red shale. The coal measures extend to the head of Frozen run, the mines being on the hill between Frozen run and Red run. The strata here are very similar to those at Ralston, except that the coal beds are not quite so thick. The elevation of the red shale containing the ore is seven hundred and ninety feet above the rail road. The ore band varies from four and a-half to six feet in thickness, the upper half containing the richest ore, which, remote from the outcrop, is nearly solid. Upon it rests four feet of shale. Ascending, the rocks are conglomerate and sandstone, eighty-five feet, coal eighteen inches, brown shale, a heavy bed of sandstone, coal two feet four inches; and a little higher, another coal, eighteen inches producing a good article for coking. This last lies nine hundred and sixty feet above the railroad at the mouth of Frozen run, and the hill rises about thirty feet higher. Near the base of the hill is the usual band of limestone occurring near the top of F. IX. It is too impure to be employed as a flux in the furnace, limestone for that purpose being brought from Williamsport, and employed in the ratio of one ton for each ton of cast iron made.

The furnace at this place is forty feet high, and ten feet six inches in diameter at the boshes. It has been in successful operation only at intervals for about two years; but has recently produced an iron of very excellent quality for foundry use: the castings being highly esteemed.

Crossing Laurel hill by the road up Trout run, a north dip is observed on the south side of the stream, and a south dip on the north side, indicating this as the position of the synclinal axis of the coal basin. Ascending the hill we have indications of F. IX. for an elevation of from three hundred to four hundred feet. This is succeeded by F. X.; on the upper side of which we find the two bands of red shale constituting F. XI. *Iron ore*, in loose pieces, was found near the upper of these beds of red shale, and not far from the summit of the hill, which is surmounted by the coarse white sandstone and conglomerate of F. XII. Above this last rock, one of the lower beds of coal

may possibly exist, where the knobs rise to a sufficient height from this level. Little doubt can prevail, that the red shale below the conglomerate includes a band of iron ore similar to that found at Ralston.

The country south of Laurel hill is extremely rough, being covered by Fs. IX. and X.; but that north of the hill is more gently undulating, F. IX. alone capping the hills and producing a soil fit for farming.—The northern anticlinal axis of the Ralston basin crosses the road a little south of the county line, while the southern axis passes near the head of Trout run.

The next place in our progress west, where this basis contains coal, is on the first fork of Pine Creek. Heavy masses of conglomerate strew the flats along the first fork, about three miles from the mouth of Bear Run, which heads near Larry's Creek. We no longer find F. IX. above the streams, but it rises to their level near the Block House fork, and a little below the old English mills. The hills are between seven hundred and eight hundred feet high, containing about one hundred feet of the conglomerate, supporting one hundred feet more of higher strata. On a stream known as Three Mile, or Porcupine Run, opposite Wolf Run, the conglomerate, and above it, the brown sandstone, are well exposed. Between them no bed of coal was discovered; but above the sandstone, a coal-seam was found consisting of two bands, each about one foot thick, separated by a layer of hard shale. The lower band in this seam is a beautiful black shining coal. Below it lies a bed of hard blue shale. Much search was made for iron ore, but without success. Whether other beds of coal exist in this neighborhood, is uncertain; but the country seems well deserving of further investigation. The conglomerate caps the hills on both sides of the fork, a little distance north and south from the spot where the coal was found. On the east side of the fork, and on the Block House Branch, the indications of coal are less promising than on the west side. An unsuccessful search was made for the iron ore of F. XI. A ferruginous band in the red shale about one hundred and fifty feet beneath the conglomerate, implies that ore might be found here if an adequately minute exploration were made, assisted by proper diggings. Specimens seemingly of good quality were found sticking in the upturned roots of trees between Porcupine Run, and the old English mills.

About the time these discoveries on the first fork of Pine Creek were made, a person seeking for limestone on a wild tract a few miles to the west, stumbled upon a bed of coal: a continuation perhaps of the seam above described. In tracing the basin in that direction, other beds were discovered and opened, to which I shall now refer. The locality is at the sources of Otter, Day's, and English's runs, which empty into the first fork, and of Trout run, which empties into Big Pine Creek, below the second fork; the property belongs to General Keim of Reading. The surface is gently rolling, but very elevated; the obscurity of the exposures, and a considerable amount of dip in the strata, causes the tracing of the coal in this neighborhood

to be rather intricate, as a section made across the basin here would show.

On the very highest lands to the north and north-west, F. XII. either caps the summits or leaves very little room for the "brown rock" which overlies it. A dip to the south carries down these rocks, and soon brings in the coal at a level considerably below the tops of the hills; but the ground continuing to slope also to the south and east, renders it difficult to determine how far the coal extends in those directions. About three miles north on the road towards Babb's, the hill suddenly falls off about two hundred feet, exposing the upper band of F. XI. and the upper part of F. X. brought to this elevation by the southern dip. Still further north, the level of the country is much lower than where F. XII. occurs. Where the road crosses Otter Run, the "brown rock" above the conglomerate just rises to the surface, forming the lower part of the bank; above this is the lowest coal seam, which is two feet six inches thick, containing a thin band of fireclay, and underlaid by another bed of fireclay two feet thick. The outcrop of another coal seam, shows itself a little higher up in the same digging. The fire-clay mentioned is of good quality, suitable for the manufacture of fire-bricks. Another coal bed was found twenty-five feet above in a neighboring bench in the hill. It was opened too near the surface to ascertain its quality; its thickness is three feet and eight inches, including two inches of slate. Below it lies a bed of fire-clay, similar to that of the middle coal seam. The extent of this upper bed cannot be great, but the other beds underlie probably fifty acres of surface, or perhaps more.

Tracing the conglomerate towards the north, it appears near the top as a coarse pebbly rock, and lower down, as a reddish brown sandstone. The thickness of the whole stratum is about one hundred and fifty feet. On the northern slope of the hill towards the old English settlement, F. XI. appears. A careful search was here made for the iron ore.—About two hundred feet lower down, the soil indicates the lower red shale bed, and here possibly the iron ore may exist. The hills north-west of the coal openings rise more suddenly, and contain the conglomerate. How much further the coal measures extend towards the south and east, can only be ascertained by systematic diggings and accurate measurement, beyond the resources of the survey. At some places in those directions, the elevation seems to be as great as at the coal, but a change of dip must occur before we proceed far in that course. The brown sandstone is exposed below the coal on Otter run.

Coal may hereafter be found at other points on these high lands between the First Fork and Big Pine creek, but it cannot occupy much extent of surface. It may be worth the attention of the owners of lands lying at the head of the south-west branch of Otter run, about five miles from Callahan's, to excavate for coal, as the appearances here are indicative of the coal measures, and the conglomerate does not reach to the highest summits of the country. Examinations were made here, both for the coal and the iron ore of F. XI. A pit dug in

the red shale about twelve feet, did not, however, bring either mineral to light; but it is probable that the ore exists, if at all, in this neighborhood, chiefly in the lower bed of red shale: for we subsequently found it there on the west side of Pine creek, nearly opposite Callahan's. At this spot it is not, however, well exposed, being only about six inches thick, and composed of hollow elliptical nodules, containing sometimes an undecomposed blue centre.

Tome's creek enters Pine creek on its west side, heading near the corner of Lycoming county. The anticlinal axis north of the coal basin we have been describing, crosses the main creek just above their junction. Ascending the mountain by a road crossing over to the Coudersport road, the rocks of F. IX. show themselves for the first two-thirds of the way up. Near the top of the formation, we meet with two beds of the *blue calcareous conglomerate*, and another about one hundred feet higher up, among the lower beds of F. X. which continues for one hundred feet more. Above this, we find a bed of iron ore in F. XI. at one time dug in several places. It varies in thickness from two to three feet. From the iron ore to the top of the hill, a vertical space of forty feet, the rock is the white sandstone of F. XII. presenting at the summit many pebbles. Near Herod's, on the Coudersport road, the surface is a little higher than the conglomerate, and consequently a small bed of coal, one foot in thickness, has been found. This coal belongs to another basin lying considerably north of the anticlinal axis above mentioned, and entirely out of the range of the second or Ralston basin. In this neighborhood, the conglomerate and sandstone of F. XII. yield a white sand, which would be well adapted for making glass.

The next coal basin toward the north, or the third in order, is that of Blossburg, on the Tioga river. The hills on the south side of the river, for a few miles above Blossburg, are capped by the conglomerate; the red shale rocks of F. IX. come out on their southern slopes, the dip to the north being considerable. No coal has been found on that side of the river, excepting near Blossburg; though it may possibly exist south of the valley, near its source. The coal formation extends eastward nearly to the head waters of Tioga river, but has not the thickness which it attains further West. On a stream called Little Falls run, nine miles above Blossburg, openings were made some years ago, under the direction of one of the mining companies of Blossburg, developing a seam of coal about three feet thick, and small bands of iron ore. A bed of conglomerate, twenty feet thick, occurs here between the layers of slaty sandstone, dividing this last rock into two portions; the lower one being of considerable thickness, the upper slaty sandstone sustaining the seam of coal. Above the coal rests a bed of black shale nearly twenty feet thick, containing *kidney-formed iron ore* of excellent quality, though not abundant; above which are three layers of a poorer species of iron ore in flat slabs, measuring four inches in thickness. Over the shale with ore, lies a bed of slaty sandstone, extending to the summit of the hill. The dip of the beds at this place, is towards the north. At the eastern side of this hill,

the sandstone forming the summit, containing some small pebbles, resembles somewhat a conglomerate. It includes some small bands of coal.

The next stream towards the west, which furnishes a good view of the strata, is Fellow's run; but no coal has been opened upon it. About three miles above its mouth, this stream descends into a beautiful and picturesque water-fall, the whole height of which, embracing three leaps, is sixty feet. Below the lowest of these, the conglomerate and sandstone rock rises perpendicularly to a greater height than that of the falls. The height of the top of the water-fall or of the conglomerate rock, is about four hundred and thirty feet above the bridge at Blossburg, while the elevation of the same on Morris' run, lying further west, is about three hundred feet. On Morris' run, about three miles above its mouth, at the height of three hundred and twenty-two feet above the Blossburg bridge, a seam of coal was opened some years ago, more than six feet in thickness. It has a roof of fireclay about six inches thick, which must be mined with the coal. Beneath the coal lies a bed of shale, twelve feet thick, said to rest on another seam of coal, probably a thin one; and below this is found a thin bedded sandstone, extending for a moderate depth to the top of the conglomerate. Higher up the run, in endeavoring to remove some of the loose material covering the rocks, a large lump of excellent kidney ore was found, weighing at least two hundred pounds. This had fallen, no doubt, from some bed in the side of the hill. Pieces of coal occur in the swampy ground, but whether they belong to a regular bed, can only be determined by draining and digging.

About forty feet above the large vein of coal, many large nodules of a rich iron ore were discovered among the roots of an upturned tree. Their abundance was such as to indicate a considerable band of the ore. A little lower lies a bed of dark blue shale, enclosing a seam of slaty cannel coal, of unknown thickness. Other beds of coal may possibly have been met with still higher up, or perhaps the exposure seen was only the outcrop of these same seams repeated; little satisfactory information being at present preserved concerning the earlier diggings in this vicinity. The access to these localities, is through a succession of thick woods and tangled laurel swamps; though the country is not unsuitable to the construction of roads.

As some anticipations exist that the coal will be developed in Elk mountain, the southern margin of the basin, it may be desirable to present in this place a general description of its summit. Near the top of a high ridge between the forks of Carpenter's run, a tributary of the Tioga, from the south, occurs a stratum of fine grained white sandstone, which readily disintegrates into good glass maker's sand. Below this, we meet many loose pieces of conglomerate, which occurs in place 100 feet higher up, constituting benches within fifty feet of the summit, and about 500 feet above the Tioga river. This rock is about fifty feet in thickness, being in some places a coarse conglomerate, in others passing into sandstone. This bed caps the whole ridge opposite the mouth of Fellow's run, for a mile or more back from the

river. Its dip is towards the N. N. W. The same rock has been encountered further east on the same side of the Tioga, forming the summit of the hills. It is in vain therefore to look for workable coal in these positions; the most that can be hoped for, being a small imperfect seam, occasionally found beneath this stratum, about ten inches thick.

The rocks in the bottom lands along the river above Blossburg, belong to F. X., and contain some layers suitable for whetstones. Formation IX. does not show itself.

Coal run, upon which some of the mines above Blossburg are situated, enters the Tioga from the north-east. Its source is not quite a mile from the river. The hills around it are 400 feet above Blossburg. A nearly continuous section of the strata was obtained on this run. The highest bed measured, is at an elevation of about 284 feet above the river, above which occurs a considerable thickness of rocks without exposures.

Section at Coal Run.

Brown sandstone,		
Kidney ore, shut out by the sandstone,		
Shale, a thin bed,		
Coal, chiefly cannel coal,	3	feet.
Fireclay,	2	6 in.
Shale,	15	
Coal,	1	6
Fireclay,	2	6
Shale,	2	
Nodular ore,		4
Blue shale,	3	
Coal,	3	6
Fireclay,	2	6
Shale,	10	
Sandstone with vegetable remains,	30	
Fireclay,		6
Cannel coal, with two seams of slate, one 1 foot the other 3 inches thick,	2	7
Shale, containing rich kidney form ore, the aggregate thickness is about 6 inches, all lying within 3 feet,	32	
Coal too far below the ore to be worked with it,	1	
Sandstone,	30	
Cannel coal,	2	
Olive colored shale,		
Sandstone with vegetable remains, passing into a conglomerate towards its lower part.		

Below these strata, we meet with the red shales of F. X., alternating with sandstone. Diggings have been made in this red shale, for

-iron ore, two unimportant bands of which were discovered. Near the upper red shale, is a bed of fireclay.

The next vertical section measured, is on Bear Creek, north of Coal Run, but on the same side of the river. A thick bed of sandstone, part of which is pebbly, and about fifty feet thick, forms the upper rock in this hill, above the coal-mines. The following series, commencing a few feet below the bottom of this rock, exhibits the composition of this hill :

Coal, variable, but sometimes	1 foot, 6 inches.
Shale, containing four inches of iron ore, ten to twelve feet,	12 " 0 "
Coal,	3 " 7 "
Fireclay, two to three feet,	3 " 0 "
Coal, lower half cannel coal,	1 " 2 "
Dark sandstone, with purplish stripes,	12 " 0 "
Coal,	1 " 6 "
Stratum not measured,	
Sandstone, imbedding pebbles,	30 " 0 "
Bed containing iron ore, three to five feet,	4 " 0 "
Stratum not measured.	
Sandstone.	
Stratum not measured.	
Red and yellow shales of F. XI.	

The upper coal occurs on the south side of the creek, where it is one foot six inches thick ; but on the north side, it is entirely wanting. The ore in the next stratum is good, but small in quantity ; this bed is also visible on Coal Run. The next bed is the main coal seam at Blossburg ; it has been opened in five different drifts, two on the south side and three on the north side of the creek, at an elevation of about two hundred and eighty feet above the rail road, not quite a mile distant. The quality of this coal is somewhat injured by the amount of sulphuret of iron occasionally present, from which the chief part of the bed is comparatively free, having a fine brilliant lustre. A fault crossing the three drifts on the north side of the creek in a north-east and south-west course, throws down the coal three feet. Large quantities of this coal are carried down the Tioga valley in the winter.—

The fireclay under this coal contains fossil-stems of the genus *cactus*. At its outcrop occurs a large deposit of exceedingly tough clay, derived from this bed, well adapted for the manufacture of fire-bricks. The eighteen inch seam of coal was at one time partially mined, but has since been abandoned. The sandstone which underlies this, is rather remarkable, passing in its lower beds into a coarse conglomerate. We have not yet determined whether this bed marks the bottom of the coal measures. Under it lies another bed of sandstone, and beneath that the red shales of F. XI. Below the conglomerate, a rather singular band of ore has been met with, which thinned out after being pursued for a few feet in. It would justify further exploration. The shale containing this ore is nearly five feet thick, consisting largely at its outcrop, of long elliptical balls of a very argilla-

aceous brown ore, lying closely adjacent to each other, and forming more than one-half of the stratum. Each elongated nodule, consists externally of a series of concentric crusts, which readily peel off by exposure to the atmosphere. Beneath the balls, lies a nearly solid layer of a heavy yellowish-gray ore, about six inches thick, having a true oolitic structure. These beds appear to be shut out by the overhanging sandstone, at a short distance in from the surface. Other excavations have been made for ore in the other red bands lower down in the series, but unsuccessfully. The conglomerate and sandstone of the two beds described, strew the hill-sides in great quantity, and furnish an excellent building material.

Half a mile north of Bear Creek and parallel with it, is the denuded valley of East Creek, on the northern side of which the hill is capped by a thick bed of sandstone passing towards its lower part into a conglomerate. Underneath this lies a stratum of brown shale, fifteen feet thick, containing four bands of nodular ore, included in a thickness of seven feet of shale, the aggregate thickness of the ore being thirteen inches. This bed of ore is the most promising hitherto met with in the region. The chemical composition of this ore will be seen in Cap. VI.

Below the shale is a thin layer of sandstone; then a black shale, including a thin seam of cannel coal; and fifteen feet under this, it is said another seam of ore occurs fifteen inches thick; and beneath it again a bed of coal twenty-one inches in thickness.

A considerable southern dip occurring between East creek hill and Bear creek hill, the sandstone capping the summit of the former, is probably the same as that which underlies the coal openings along the latter. On Limestone Hill, half a mile further north, the highest rocks are the thin beaded sandstones of F. X. extending from within two hundred feet of the base to the summit. At its base the limestone so often found, at the alternation of F. IX. and F. X. shows itself, with a thickness of at least eight feet, consisting of heterogeneous materials, closely cemented by calcareous matter. It has a variegated aspect, like certain *breccais*. It is a durable rock, well adapted for building stone, but it is too impure to be converted into lime. It is underlaid by a blueish, micaceous sandstone, furnishing an excellent building stone. The dip here is at an angle of five degrees towards the S. S. E. North of Limestone Hill, some of the lower layers of F. IX. appear above the bed of the valley. In one particular band of red, micaceous sandstone, occur numerous mutilated remains of a highly curious fossil fish, the *Holoptychui* of *Agassiz*. Further north, still lower rocks appear.

On the west side of the Tioga river between the heads of Johnson's creek and Boon's creek, three miles from Blossburg, the coal measures occupy the hills, though little is known of them at this locality. The following account of the stratification on Johnson's creek, was furnished by the superintendent of the mines at Blossburg. Near the summit occurs a shale containing nodular iron ore; below this, a bed of coal two feet two inches thick; then fifteen or twenty feet of sand-

stone, then another coal seam embracing two feet five inches of coal, fifteen inches slate and twenty-two inches coal; in all, a bed about six feet in thickness.

On West Hill near the mouth of Johnson's creek, there is a sandstone passing into fine grained conglomerate about fifty feet in thickness, underlaid by four feet of olive colored shale, containing about two feet in the aggregate, of *iron ore* near its outcrop. The lower portion of this ore is of a greenish gray color; the upper is reddish, and sometimes oolitic in its structure.

At the outcrop, the greenish gray kind is one foot four inches thick, the red ore nine inches. The whole bed shows signs of diminishing in thickness, when followed in towards the hill, but possibly it may again augment. At the foot of the hill a considerable deposit of *bog ore* has been collected, apparently from this stratum.

From the foregoing remarks, it will appear that the principal supply of coal at Blossburg, must come from one seam, and that this occurs in greatest thickness on Morris' run, six miles from the village where it is about six feet from floor to roof. No bed of iron ore has been yet discovered, which will justify, I conceive, the construction of a large furnace, though some of those already opened may prove sufficiently productive when further explored.

Crossing this coal basin at a point further west, in a south-east direction from the south-west corner of Charleston township, the following features present themselves. The hills in this part of the township are capped by F. XII., the material used in the construction of the Court House at Wellsborough. Passing south-eastward crosses the forks of the First Fork or Babb's creek, the conglomerate is seen to occupy the tops of all the high ridges, being no where met with below the summit. The upturned roots of the trees furnish no indications of coal smut. Southward to the head waters of the First Fork, near the Blossburg road, the conglomerate caps the summits. In so wild a country, it is impossible always to pronounce with positiveness upon the non-existence of coal in a part of the basin like this, where a slight dip may bring in, unperceived, the lower part of the coal measures. This neighborhood was carefully examined, and if the coal does prevail, it cannot cover much extent. Further west over Wilson's or Yarnall's creek, entering the first fork at Baab's, and heading towards Wellsborough, the coal measures have been discovered, and the coal opened on the west side of the stream. On the east or opposite side, coal smut was also found by us at the mouth of Wilson's creek. The dip is gently northward; and about five miles above or towards the north, it is southward, forming the basin, in the centre of which lie these insulated patches of coal measures. The tops of the hills at the two boundaries mentioned, consist of the conglomerate, on the very highest knobs or the brown rock above it; gradually descending to a rather lower level in the basin, they have over them for a considerable extent of surface, a moderate thickness of strata, which may be found to contain one seam of coal. Between one hundred and two hundred feet below the conglomerate, there occur abundant signs of a bed of

iron ore, visible along the brow of the hills on each side of Wilson's creek. Some amount of excavation, however, would be requisite to develop it. Along Wilson's creek, F. X. is not very thick, the hills containing the coal measures being apparently not more than six hundred feet high, while F. IX. just appears above the bed of the valley. The coal occurs between two and three miles above Baab's, at the mouth of Wilson's creek. It overlies a bed of sandstone reposing above the conglomerate. The floor of the coal is a dark brown shale. The seam is double, the upper portion being one foot in thickness, the lower, eighteen inches, both of good quality. They are separated by a band of dark shale one foot in thickness; the roof of the coal bed consists of black shale full of vegetable fossils. The hill rises only about thirty feet higher than the level of the coal, and presents no indications of another seam, or of a band of iron ore, though much search was made. Half a mile north from the opening made in the coal, the conglomerate rock is finely exposed, exhibiting itself in a bed of about thirty-five feet thick. Receding a little from the front of the hill, a bench rises about thirty feet from the conglomerate. On the top of this flat the upturned roots of the fallen trees, disclose numerous fragments of iron ore. The indications of ore are tolerably abundant from this point across to the Stony Fork, and the smut of the coal is also traceable throughout the same tract, but whether more than one coal bed occurs, cannot be ascertained without much excavation.—The conglomerate lies high, but some points of the surface tower a little above it. The outline of these high lands is undulating, the growth is open, and would furnish much timber adapted for making charcoal. On both sides of the Stony Fork the conglomerate crowns most of the hills until we advance several miles up the stream, where the lower rocks form the surface. This formation is well exposed in this vicinity, forming often an irregular line of escarpment around the brow of the hill for many miles in extent, where enormous blocks, dislodged from the stratum, open lanes and passages between them and the main bed. In the bed of the valley of Stony Fork, the impure, calcareous rock near the top of F. IX. sometimes shows itself. About three miles from the mouth on the east side, a very ferruginous spring appears, depositing a large mass of brown ochre. A little above this spring, an excavation was made in search of ore, and a band of small compact nodules, whitish within and coated with a brown crust, was found, imbedded in a shale. After penetrating to a depth of a foot and a half, a copious ingress of water arrested the digging. This band of ore, is conceived to be a continuation of that already discovered in so many places in F. XI. The same band was found some years since, several miles to the west, on Pine creek. On the west side of Stony Fork, the red shale below the conglomerate is very ferruginous.

Between the layers of the conglomerate, a short distance from the bottom, a thin band of black shale, readily mistaken at first for the crop of a seam of coal, was found. As it is somewhat continuous, though only one foot thick, it is desirable thus to mention its position,

lest it may mislead. Over the conglomerate on the same side of the stream, the ground rising twenty or thirty feet, a few pieces of kidney ore were discovered. Diggings being made, the bed, however, proved to be thin and irregular, being a band in the brown sandstone. Signs of the same seam were met with in other places, in a corresponding position in the strata, but no where gave promise of being productive.

At the mouth of the second fork of Pine creek, the rocks dipping gently to the north, F. IX. extends from the bed of the valley a considerable way up the hills, the conglomerate capping only the highest knobs, and no coal measures appearing above this along Pine creek. The only chance we have of finding them is above the head of Elk run, entering Pine creek a mile and a half above the mouth of the second fork. Here a bed of iron ore was opened a few years ago, below the conglomerate, being probably the same found upon Stony Fork. It was mined for a short distance in by a regular drift, and proved to be between three and four feet in thickness; the whole of which, however, is not ore, a portion consisting of imbedding shale. On Big Pine creek, about four miles above the mouth of the second fork, the rocks, previously nearly horizontal, dip south, bringing in the conglomerate on the summit of the hills, about two miles below this on the east side of the stream. This very shallow basin in the rocks will, therefore, probably not yield any coal along Pine creek.

Retracing our way eastward to the Tioga river, these southern dips are seen to continue from the northern margin of the Blossburg basin, down the stream to a point about midway between Covington and Mansfield. The hills here are low and gently rounded, and consist only of the beds of F. VIII. At Covington, they are capped by F. IX. A band in F. VIII. has been found sufficiently calcareous to yield lime. It is full of fossil shells. North of the flat anticlinal axis between Covington and Mansfield, the northern dips bring in F. X., which caps a belt of higher hills ranging north of the latter town. The dip again changes to the south, about two or three miles north of the mouth of Mile creek, and continues southward as far as the northern boundary of the state. Tracing the anticlinal axis which divides the Blossburg coal measures from the northern unproductive basin, we find it bringing the rocks of F. VIII. to the surface, along the whole belt of country crossing Wilson's creek, Stony Fork, and Big Pine creek, near the Round Island. The gentle depression of the strata to the W. S. W., causes all but the very upper layers of F. VIII. to sink out of view on Pine creek. The calcareous, fossiliferous bands of this formation, occur on Stony Fork, but afford a very indifferent lime. Near the brink of this stream in the alternations of F. VIII. and F. IX. issues a small saline spring, capable of affording a bitter salt. Some years since, an attempt was made to bore for brine at this spot, and the strata were penetrated to the depth of about three hundred feet without procuring and further supply, when the augur broke and the work was given up. The true saliferous rocks of our state are much higher in the series, being the white and porous sandstones of the lower coal measures and of F. XII., and these are

never productive in brine, unless when they occur at a considerable depth below the beds of the vallies.

On the Tioga river, the northern dip, carrying down the rocks of F. VIII., forms a broad but shallow basin between Mansfield and the mouth of Mile creek. The Tioga river crosses the bottom of this basin above Tioga village, displaying the rocks of F. IX. Receding from the river, the hills are capped by F. X.; and it has been said that the very highest knobs take in small patches of F. XII. Denudation has, therefore, swept away every remnant of the coal measures which may once have occupied the centre of this trough.

Tracing this northernmost basin westward, we find it crossing Crooked creek, a little north of the Big marsh. The hills bounding it on the north and south being capped by the F. X., the gray slates of F. VIII. appear in the valley between. The town of Wellsborough lies in the latter formation.

About eight miles northwest from the Big Meadows, occurs a bed of iron ore, from which a large deposit of brown ochre has been produced. Much ore has been taken from this spot. The ore band has not been fully developed. It occurs within one hundred feet of the summit of the hill, lying probably below the conglomerate, though that rock does not appear. About two tons only of loose, nodular ore have been excavated. Twenty feet below this bed, a bench or broad terrace occupies the flank of the hill, embracing about twenty acres of surface. It is covered by a rich deposit of the bog ore, to a depth averaging perhaps two feet. Higher on the hill a small seam of coal, one foot in thickness, occurs, which is of limited extent. Near the summit of the hill, are indications of another bed of iron ore.

CHAPTER V.

Sketch of the Geology of that part of Western District of the State which embraces the counties of Armstrong, Clarion, Venango, Butler, Beaver and Mercer.

Though the bituminous coal measures of our state constitute, in strictness but one group of sandstones, limestones, shales and coal seams, not susceptible of any *natural* sub-division, the expediency of adopting some classification of so extensive and complicated a system of rocks, induces me to separate the whole, into an *upper* and *lower* series, and to designate these by the geographical regions which

they occupy. The two chief rivers which traverse the basin, flowing in opposite directions, intersect wholly different strata, the Monongahela and its western tributaries passing through the upper coal measures, and the Allegheny through the lower. Starting from the marly shales exposed at the water's edge at Pittsburg, and ascending the former river, we rise into higher and higher layers, and following its western streams into Wayne county, we may even reach the uppermost beds of the whole series. Ascending the latter river on the other hand, we come upon lower and lower rocks, emerging successively to view, until, in the neighborhood of Franklin and Warren, we encounter those that form the bottom of the basin. I propose, therefore, to call the upper coal measures exposed in the valley of the one river, the *Monongahela Series*, and the lower strata, as they are developed in the valley of the other, the *Allegheny Series*. The Monongahela series includes the beds entitled the *Pittsburg Series* in my last annual report.

When the task of tracing the range of the several strata throughout the whole coal basin shall have been completed, and the respective areas of those two divisions of the formation ascertained, the Monongahela series will be found not to extend beyond the limits of Allegheny, Washington and Green counties, the southern townships of Beaver and Armstrong, the south-western ones of Indiana, and all those sections of Westmoreland and Fayette lying north-west of a line near the base of Chesnut Ridge. All other parts of the general coal field situated to the north-west of the Allegheny mountain, are occupied by the Allegheny series to be here described. The boundary between the two series marked by the final outcrop of the shales which are exposed just above the Ohio river at Pittsburg, will not deviate greatly, when ultimately traced, from a line ranging as follows: Commencing at the Ohio river, near the mouth of Yellow creek, and running thence nearly eastward, it crosses the same river again near Economy; and the Allegheny river about the mouth of Bull creek, then deflects a little to the north, passing the Kiskiminitas a few miles above its mouth, and ranging north of Crooked creek, which it also crosses. Assuming a nearly eastern course, it runs north of the town of Indiana, near which it sweeps to the south and south-west, and then follows the base of Chesnut Ridge and west Laurel Hill, to the Maryland line. The country south and west of this boundary is occupied exclusively by the Monongahela series.

COAL MEASURES.—*Allegheny Series.*

Description of the Lower Coal Measures as they occur between Pittsburg and Warren, on both sides of the Allegheny River, adopting the descending order and proceeding Northward.

Having in my last annual report enumerated and described the various beds of the bituminous coal measures of the western counties of the State, which compose that part of the series overlying the

lowest stratum exposed at Pittsburg; I propose in the present place to give a similar account of those layers embraced between the same stratum and the sandstones and conglomerate at the bottom of the coal formation. To render this enumeration more intelligible, I shall commence at Pittsburg, in the neighborhood of which the strata are well exposed and familiarly known, and discuss them in the *descending* order as they rise in succession to the level of the Allegheny river between that town and Warren, this being the order of their outcrop from the centre towards the margin of the basin. While specifying the features and composition of each division of the series as it appears adjacent to the Allegheny river, I shall also refer to it in other places, in order to show its range both east and west of that great intersecting valley; but the confined limits of an annual report, and the unfinished state of the geological map, will prevent my attempting to delineate the outcrop of each stratum, or to introduce more than a few localities at which it may be seen. The intelligent reader, *with the Map of the State before him*, will, however, be enabled, it is hoped, with the assistance of these localities and the descriptions given, to trace with sufficient accuracy the range of each important coal bed and other sub-division of the series.

It may be proper in this place to offer some explanatory remarks in reference to the strata exposed on the Allegheny river, between Pittsburg and Freeport; a clear understanding of which will render intelligible to the most cursory observer, the general range and nature of the rocks comprising the northern half of the great western coal basin. The variations in the shales and sandstones present occasionally great difficulties in identifying them. It should be remembered, also, that the divisions of the strata adopted in my reports, though rendered necessary by the nature of the coal measures, are, in fact, more or less arbitrary divisions, which exist with rather less distinctness in nature than might appear from the definite limits assumed for sake of description. Hence, a practical observer, not conversant with geological research, may err in comparing our general accounts with the exposures in some particular neighborhoods.

While the rocks composing the present series are all under the Ohio at Pittsburg, and rise and crop out successively towards the E. the N. E. the N. and N. W., forming an elliptical basin, their dip is by no means regular, but *undulates* considerably, the local inclination differing in a multitude of cases from the general one. Thus, below Freeport, at some of the coal mines, the *local dip* is up the river, while in fact the *general dip* is in the contrary direction, as is shown by the coal cropping out on the north and sinking under the Ohio to the south. The coal vein just described makes its appearance on Pine creek, owing to a local rise in the strata, while it does not show itself above the Allegheny until within a few hundred feet of Tarentum. At Pittsburg it appears to be from one hundred to one hundred and fifty feet below the river, while at Freeport it has the height of one hundred and forty feet above the water. At Kittanning it is still higher, rising further north to the tops of the most elevated hills, and finally cropping

out, and occurring, at intermediate points, much lower than a regular dip would carry it.

The variegated shale composing No. 1 of the Monongahela series, is found at the base of all the hills surrounding Pittsburg, and is completely exposed on the river as far as Sharpsburg. Here the hills consist of the same rocks as at Pittsburg, but the shale is higher, causing the Pittsburg coal to be found only on the highest knobs, while the first two strata of the present series begin to show themselves in the lowest places. The sandstones No. 4 and No. 5 of the Monongahela series are here quarried, while the colored shales above them are all well exposed. At Fairview, five miles higher up the river, we find the hills about three hundred and fifty feet high, and too low for the Pittsburg coal; while the colored shales of the Monongahela series compose the upper part of the hills, forming a compact bed one hundred and seventy feet above the water, resting on No. 4 and No. 5 of that series. The bed No. 5 is a compact sandstone, quarried extensively at Alexander's quarry, one mile above, and also at numerous points on the other side of the river. When we arrive at Tarentum, we find that still more of that series has vanished, including the above sandstones. The river hills average two hundred and fifty feet, while the coal, No. 6 of the Allegheny series, has just made its appearance above the canal, with the accompanying strata. At Freeport, the hills are composed almost entirely of the same strata, their denuded summits being in a few instances formed by the colored shales and slaty sandstones of the Monongahela series, while at Kittanning we see at an elevation of one hundred feet the fossiliferous limestone and other rocks which were far beneath the river level at Freeport, and the last remains of the Monongahela series are indicated by the red and variegated shales which cap the high hills on on both sides of the river.

No. 1.—Slaty Argillaceous Sandstone.

Commencing our enumeration of the rocks of the coal measures, with the first bed immediately beneath the red and blue calcareous shale lying at the base of the hills around Pittsburg, we meet with an unimportant and somewhat variable stratum, first well disclosed at the mouth of Cirties' Run, and Pine Creek. It consists of a light greyish slaty sandstone, generally in thin layers, and usually in a fragmentary condition wherever it has been much exposed. The beds numbered 1, 2, and 3, in the Pittsburg, or Monongahela series, described in my last report, conceal this rock along the river from Pittsburg to Sharpsburg. Beyond the point where it emerges, it is quarried in several places, but is generally too soft to be a useful building stone. It forms the bed and margin of Pine, Deer, Sandy, and Plum creeks, and is also visible on Saw-mill Run, Cirties' and Higby's runs, and in most of the ravines along the river hills between Pittsburg and Tarentum. At Freeport, and in the neighborhood of Kittanning, the true position of this stratum should be on the summits of the very

highest hills. From all those of less height, it has been removed by denudation. Gradually thinning out in this direction, it becomes indistinguishable from the inferior strata. Average thickness thirty feet.

No. 2.—*Shale.*

The argillaceous sandstone just described, is seen to be overlaid by a bed of yellow and brown shale, into which it gradually passes, and which indeed is merely the inferior portion of the same deposit. This is exposed along many of the streams and ravines above referred to. We detect it at Freeport, resting upon the thick sandstone which overlies the upper coal seam at that place. Near Kittanning, it occurs on the river hills in contact with the small bed of coal to be next mentioned. Iron ore has not hitherto been noticed in this shale in any quantity. Thickness in considerable.

No. 3.—*Coal.*

A seam of coal, about one foot thick, overlaid by the above shale, shows itself in the river hills fifteen miles above Pittsburg. It is not recognized again until we approach Kittanning, where a band of coal identical with it in position as far as can be ascertained, has been opened near the summits of the hills. At Allegheny furnace, it is two feet thick, but not of sufficient value to lead to its being mined. This seam of coal has been particularized chiefly with a view to prevent persons from confounding it with workable seams situated lower in the series. It ranges westwardly to the vicinity of Butler, where it could probably be detected, were it of sufficient value to justify a minute exploration. It is prolonged, likewise, through the north-west corner of Westmoreland county.

No. 4—*Sandstones and Shale.*

In this division are embraced some beds which are peculiarly interesting, as they produce a marked influence upon the physical features of the district where they appear. Their variable character tends at the same time, not a little to embarrass the geological inquirer. While the coal seam, and beds of limestone, are traceable with comparatively little modification of aspect or composition, over an extensive range, these intrinsically less useful strata, are much less easily followed. Being more or less irregular accumulations of sand and clay somewhat promiscuously deposited by conflicting currents, a considerable diversity of composition, is apparent wherever we compare them at distant points. Throughout the coal measures generally, the sandstones vary in appearance, when traced sometimes only a few feet, and often thin out entirely in the distance of a few miles, beds of shale, totally different in their nature replacing them.

Overlying the upper coal seam on the Allegheny river below Free-

port, we find a thick bed of sandstone, consisting of two layers, each averaging thirty-five feet in thickness, and separated by about twenty five feet of shale. The sandstone is remarkably coarse, and very compact and heavy. It assumes, in many places, the aspect of a true conglomerate, particularly in the lower layers of the upper stratum, where a band about four feet in depth consists of round water-worn pebbles of white quartz. Imbedded in this rock, are nodules of iron ore, varying from one to six inches in diameter. Immediately beneath this, we not unfrequently find about six inches of coal interstratified with slate. The lower sandstone divided from the upper by shale, and thinly bedded slaty sandstone, is of similar character. This rock in many places, affords a good building stone, and may readily be quarried.

From Tarentum to Freeport, the whole tripple mass of sandstones and shales, forms a conspicuous stratum along the river hills, gradually ascending, until it reaches their summits above the mouth of the Kiskiminitas. It forms a belt of high hills, extending north east and south-west through Buffalo township, Armstrong county. These rocks change their character materially in the vicinity of Kittaning: becoming one general stratum of slaty sandstones, with layers of interposed shale in place of two well marked beds of pure sandstone, divided by a thick belt of argillaceous shale. Spreading northward on both sides of the river, it occurs near the summits of the hills, almost as far up as the mouth of Red Bank creek, where the heights become too low to receive it.

The stratum can be traced stretching east and west from the Allegheny river, in common with the other adjacent members of the series until it crops out on the highest grounds and disappears. It is exposed on the Kiskiminitas, and also extensively throughout the eastern part of Armstrong county. In Butler county it forms the principal portion of the elevated land lying between Buffalo creek on the east, and Slippery Rock creek and its branches on the west. The hills north of the town of Butler contain it, but the stratum here is less compact than in many other situations. It extends generally through Centre, Butler, and Middlesex townships, and parts of Muddy Creek, Slippery Rock, Parker and Donegal townships, forming high hills, covered with a stunted growth of scrub oaks and other trees. A belt of naked or glade-like hills, extending from near Porterville in a north-east direction, through Slippery Rock and Parker townships, designates its northern outcrop. Removed by denudation from the lower grounds bordering Slippery Rock creek, the stratum again appears on the western side of Mercer county. Average thickness, seventy-five feet.

No. 5—Shale.

Beneath the stratum just described, and reposing upon a bed of coal, next to be mentioned, is a thick mass of brown and blackish shales, sometimes laminated, but generally very friable, and containing, like nearly all the shales of the series, more or less nodular iron ore.

Below Freeport, where the massive sandstones overlies the coal it varies from two to twenty feet in thickness; but at Kittanning it is much thicker, and in the neighborhood of Butler it measures more than fifty feet.

No. 6—Coal.

We come now to the first workable coal seam of the Allegheny series, and one of the most important and widely extended beneath the Pittsburg and Monongahela group. This bed affords a remarkably rich, compact and inflammable coal. It has been found by trial, to make an excellent coke. Different portions of the bed vary, of course, in the quality of the coal; some bands containing more or less slate and sulphuret of iron. By a little skill, this seam will be found to furnish, it is believed, in many places, a fuel equal to that derived from the main Pittsburg bed.

As the strata emerging from below the water at Pittsburg, exhibit a gently undulating and not perfectly regular dip, this bed rises about three miles below Tarentum, near which it is mined at an elevation of thirty feet, though it shows itself on Pine creek, about two and a-half miles from the river, on the land of Mr. Shaw, and others, exactly on a level with the stream. It is here six feet thick. At Peterson's salt well, one mile below Tarentum, it is of the same thickness, being opened beneath a bed of shale, at an elevation twenty-five feet higher than it occurs only half a mile further down the river, showing a gradual but irregular ascent as we trace it towards the north. At Kier's salt well, a short distance above, it is seven feet thick, and is mined forty feet above the level of the river. At Tarentum it is opened at Donnelly's salt well, and in several other places on both banks of the river, within three miles of which it is also mined on Bull creek. At Freeport this valuable coal seam lies, by measurement, one hundred and forty-four feet above the water. It here supplies Weaver's, Lowery's, Donnelly's and other salt wells. In this vicinity its average thickness is four feet, and its dip is to the S. S. W. at an inclination of about fifteen feet to the mile.

On the Kiskiminitas this seam of coal supplies fuel to a number of salt works. At Kittanning we find it at the height of three hundred and seventy feet above the river, being opened both on the east bank and at Allegheny furnace. It occurs on Mahoning and Red Bank creeks, and is well exposed at the mouth of Sugar creek, where it occupies only the summits of the higher river hills, many of which are too low to embrace it. This is not far from its northern outcrop, no trace of it occurring along the Allegheny, above the mouth of Bear creek.

This coal seam has been carefully traced through the eastern part of Armstrong county. It is opened more extensively in Allegheny, Pine, Wayne and Red Bank townships, than elsewhere. Tracing it from the river hills, from many of which it has been removed by denudation, it ranges westward through the central parts of Butler coun-

ty, and through portions of Allegheny and Beaver counties, disappearing ultimately beneath the Ohio river, in conformity with the general south-western dip of the coal measures. Near the town of Butler, where it is extensively wrought, it holds a high position in the hills. It is here four feet in thickness. It occupies a lower level on the lands of Alexander Boyd, in the north-west corner of Middlesex township, half a mile east of the township line. The general surface of the country throughout Mercer, Venango, and part of Slippery Rock townships, in this county, is not sufficiently elevated to embrace this number of the series: the fossiliferous limestone, presently to be described, constituting one of the upper rocks, throughout this district.

Ascending the Kiskiminitas, this stratum of coal is wrought in many places until it is hid below the level of the valley.

No. 7.—Non-Fossiliferous Limestone.

Supporting the above coal seam, is a bed of limestone, the true position of which is a few feet below the coal, separated from it by a soft shale, and sometimes by a hard, black, bituminous slate, containing vegetable impressions. Below Freeport, where this stratum first emerges from beneath the level of the streams, it consists not of a compact bed of limestone, but of loose nodular masses of that rock, irregularly imbedded in shale. These are very hard and fine grained, and of a light blue color, and conchoidal fracture, affording a strong but ash colored lime. Proceeding towards the north and east, the bed acquires greater compactness, and becomes valuable as a source of fertility to the soil, upon which, unfortunately, lime is not sufficiently employed.

This limestone bed occurs at the hills near Kittanning, and also on those around Red Bank and Mahoning creeks. At the mouth of Sugar creek it occupies the summits of the river hills, where it is overlaid by the coal seam, No. 6, separated from it by a calcareous shale three feet in thickness. The stratum is here four feet thick, excessively hard, of a dark blue color, and very pure. Throughout the eastern part of Armstrong county, it is traceable from the Kiskiminitas to the north side of Red Bank creek, becoming a peculiarly solid and compact bed, in Pine, Wayne, and Red Bank townships. About one mile south of Mahoning, it is opened on the farm of Mr. Peter Lais. Near the village of New Bethlehem, it shows itself on the lands of Messrs. Henry Doverspike, Thomas M'Kelvy, and others, being a hard, dark blue rock, containing only a few fossils.

Westward from the Allegheny river, it ranges in common with the overlying coal through the central parts of Butler county, cropping out on the north and west. It was discovered by us at the town of Butler, where, strange to say, it has not been wrought. It is from this stratum that the central townships of Butler county will be supplied with lime, as soon as the importance of calcareous manure

shall be duly appreciated. Here its value is enhanced by the argillaceous, ferruginous character of the soil, rendering lime especially beneficial. Through a remarkable oversight, the existence of this stratum is hardly known to the inhabitants who derive their chief supply of lime from a bed of inferior quality, No. 15, of the series, hauling it a considerable distance. It undoubtedly extends through Middlesex, Butler and Centre townships, and parts of Cranberry, Muddy creek, and Parker townships, in the latter of which, it is opened near the village of Fairview. Its proximity to the coal will not only facilitate its conversion into lime, but readily lead to its discovery, its proper situation being under the coal seam, No. 6, of the series, either in contact with it, or separated by a few feet of soft shale. It does not always occur as a compact bed, but assumes this condition as we approach its outcrop, agreeing, in this particular, with the overlying coal.

This limestone should not be confounded with the fossiliferous limestone, to be hereafter described, which, entering the river hills below Kittanning, shows itself on Buffalo creek, passes under the table land of Butler, and ultimately re-appears on Muddy creek and Slippery Rock. That limestone must lie at least two hundred feet below the level of the Conequenessing, at the town of Butler. The bed before us is distinguished from it, by rarely containing any *fossils*, although these occasionally occur in the brown calcareous shales which divide it from the overlying coal. We ought to mention that its surface frequently presents blotches of a different tint from that of the surrounding parts of the rock. These may readily be mistaken, by the inexperienced observer, for minute fossils. Thickness from three to six feet.

No. 8.—Slaty Sandstone and Shale.

Underlying the limestone, we usually find a bed of sandstone interstratified with shale, but varying much in composition. The sandstone occurs in layers from six to twelve inches thick—sometimes in contact, sometimes separated from each other by shale. This latter is generally brown, and often breaks into thin splints. In other instances it is compact, and contains a considerable quantity of nodular iron ore. At Freeport, the stratum is fifty-one feet thick; at Kittanning, forty-two feet. Average thickness about fifty feet.

No. 9.—Coal.

The next bed in the descending order is a seam of coal. This is remarkably variable. It appears above the level of the Allegheny river, about two miles above Tarentum, and is wrought at Morrison's salt-well, where it affords a good fuel. The bed is remarkably irregular as regards thickness, measuring in some places four feet; in other places only two feet. We may trace it from this point to the mouth of the Kiskiminitas, where a thin layer of soft bituminous shale, mixed

with coal, supplies its place. A similar condition of things exists at Leechburg. This coal seam, at Freeport, lies at an elevation of fifty-seven feet above the level of the river, and at a considerably greater height at Kittanning. A bed of coal, believed to be the same, appears on the Conequenessing creek, near the village of Harmony, where it is opened on the land of Jacob Ziegler. It is here of good quality, varying in thickness from two and a-half to three feet. It is also opened at Zelienople. This coal is remarkable for its irregularity, not only as respects its thickness and local dip, but as regards the nature of the accompanying strata.

No. 10.—*Sandstone.*

Beneath the above coal—sometimes in contact with it, sometimes separated by soft shale—occurs a thick bed of sandstone. This is remarkable for its variable dip and composition, the layers being often curiously contorted, apparently from their irregular mode of deposition. It contains numerous vegetable impressions. Along the Kiskiminitas, between Leechburg and Freeport, it is well exposed, occurring as a coarse grained compact gray and brownish sandstone. The vegetable impressions are frequently beautiful, belonging to the genera *Sigillaria*, *Lepidodendron*, *Calamites*, &c., the first existing in great abundance. This stratum seems to have been deposited by a rather turbulent current, if we may judge from the oblique and irregular disposition of the layers. These are often separated by thin bands of shale, and sometimes by seams of coal from six inches to two feet thick, which frequently thin out in the space of ten or twenty yards. The brown variety crumbles by exposure into a ferruginous sand.—Persons in quest of coal should avoid confounding the numerous bands in this stratum, with the more regular seams of the series from which they differ in being never continuous, ending sometimes very abruptly. Thickness seventy feet.

No. 11—*Shale.*

Between the preceding sandstone and the coal next to be described, occurs an important stratum of dark shale, containing fireclay and nodular iron ore. Some layers are soft and carbonaceous, resembling at their outcrop a coal smut; others are friable, breaking into narrow, longitudinal fragments. In some places it embraces layers of slaty sandstone, also fireclay of good quality. Near the middle of the mass are two bands of coal, requiring particular notice. The first of these is one foot thick, the other varies from one foot to eighteen inches in thickness. As we have not found these to be continuous over any great space, and as they are too thin to be profitably worked, we have not deemed it expedient to describe them as separate seams. In some localities, the laminæ of the shale are remarkably regular, and it may be procured in large plates; other portions contain much sulphuret of iron, and readily crumble by exposure. The iron ore of this stratum

is usually in slabs, irregularly scattered through the shale, but most abundant above the underlying coal.

This member of the series deserves especial attention, as it probably contains, in some situations, seams of coal worth pursuing, besides valuable deposits of iron ore and fireclay. Thickness from 75 to 100 feet.

No. 12—Coal.

Immediately underlying the above stratum, is a widely extended and important seam of coal, emerging from below the Allegheny river, about five miles above the mouth of the Kiskiminitas. At Kittaning it attains an elevation of six feet, being extensively wrought near the base of the hills, on both sides of the river. It is $3\frac{1}{2}$ feet thick. At its outcrop the coal is often inferior, but further in the hill, it affords an excellent fuel. Like all the other seams, it varies somewhat in thickness, and contains irregular nodules of sulphuret of iron. Many of the salt wells in the vicinity are supplied with fuel from this bed.

This coal seam may be readily traced on the river hills, between Kittaning and the mouth of the Clarion river. On each side of the Allegheny, we find it heading in the small streams and brooks which empty into the river. It finally sinks beneath the water level of the country, towards the south-west, to re-appear on the Beaver river and its branches. Its position above the fossiliferous limestone, to be described presently, enables us to trace it with facility and precision. Eastward of the Allegheny river, it shows itself on the Cowanshannock creek and on Crooked creek, ranging to within a short distance of the county line of Indiana, and likewise on Red Bank Creek, where it reaches to about the same distance from the Jefferson county line. Disappearing beneath the hills which form the west slope of the Allegheny river at Kittaning, it re-appears on Buffalo creek, where it is worked at Horner's Mills. Thence it passes under the high grounds in the centre of Butler county, and reaches the day once more on the Slippery Rock and other streams, towards the west. This seam is mined on the Neshannock creek.

In consequence of the changeful thickness of the shale, interposed between this coal bed and the fossiliferous limestone beneath, it sometimes rests almost in contact with the latter, though the usual thickness of the shale is from twenty-five to thirty-five feet. Considering the great extent of country occupied by these strata, and the manner in which they were deposited, some from quiet waters, some from turbulent currents, it should not surprise us that they thus vary in thickness and composition. Their position in the series, however, is constant, and a careful examination will almost invariably enable us to trace them. Thickness of the coal, from three to five feet.

On the south side of the Red Bank creek, in Red Bank township, Armstrong county, a deposit of *cannel coal* has been opened on the lands of Mr. Alexander Cathcart. Here we find a bed of common *bituminous coal* two feet thick, supporting one of *cannel coal* eight

feet six inches in thickness. The latter is light, compact, of a dull lustre, and a conchoidal fracture, and belongs to the variety denominated slaty cannel coal. It ignates with facility, burning with a bright flame, and leaving but a moderate amount of ashes. It forms a compact bed not regularly laminated, and is distinctly separated from the coal beneath. From all the evidence we could collect, without resorting to extensive digging, we conceive this coal seam to be the same with that above described. The cannel coal is not traceable beyond this neighborhood, being merely a local modification of the deposit, the remarkably bituminous roof of the bed passing into cannel coal.

Three miles from Greensburg, Beaver county, there occurs a very analogous bed of cannel coal, resting on ordinary bituminous coal.—The whole seam there is eleven feet in thickness.

No. 13.—Shale.

Below the coal just described is a bed of brown and black shale, with interposed layers of sandstone. This is an important repository of nodular *iron ore*, always containing that mineral in greater or less abundance. The ore is generally greatest in amount directly under the above mentioned coal seam, where the shale is soft and friable.—In Clarion county, and the southern part of Venango, where this stratum not unfrequently caps the hills, covering the limestone to be described, we find it to contain large quantities of blue nodular iron ore. Both in Venango and Mercer counties, the centre of the stratum is sometimes occupied by a bed of solid sandstone, occasionally ten feet in thickness. It is worthy of remark, that the iron ore abounds in proportion to the deficiency of these sandstone layers in the stratum. Average thickness twenty-five feet.

No. 14.—Burr-Stone, and Brown & Siliceous Iron Ore.

Between the shale above spoken of, and a limestone to be next described, occurs a siliceous and ferruginous deposit of great economical importance, and of singular character. When not largely impregnated with the oxide of iron, this bed constitutes a hard greyish and yellowish chert, or flint, of a somewhat cellular structure. Some portions are precisely analogous, both in composition and appearance, to the burr-stone of France. When it is much charged with the oxide of iron, with which it is in contact, the weathered specimens exhibit a worm-eaten or cavernous appearance, arising not merely from the removal of the oxide of iron lodged in it, but from the dissolution of the calcareous matter derived from the adjacent limestone. The open cellular variety is usually white or yellowish; the compact kind black, bluish, and brown. The bed is sometimes fossiliferous, containing *encrini*, and other organic remains.

Reposing directly upon the siliceous rock and passing into it, there is a highly important bed of iron ore, which has already become

of great value to the counties bordering the Allegheny river, and which is destined to occupy a still more conspicuous place among the mineral treasures of our great bituminous coal field, when its true geological relations shall be understood, and its productiveness appreciated. This ore consists generally of a mixture of the peroxide and protocarbonate of iron, the latter predominating, except near the outcrop. At its outcrop it is composed almost exclusively of the brown hydrated peroxide, and is of various tints of brown and red. Its structure is often cellular, the irregular cavities being surrounded by a thinner or thicker crust of the ore. In other instances, it occurs in large masses, in which the ore is intimately mingled with the chert, and is full of drusy cavities, lined with minute crystals of quartz, tinged red, brown, and pink, by the oxide of iron. These cavities sometimes contain water. Though this seam of ore follows the limestone over considerable spaces of country, it is not strictly continuous, but occurs rather in large patches of various thickness. The buhr-stone and the iron ore would seem indeed mutually to replace each other, the one most abounding where the other is deficient. For the chemical composition of this ore, see the *analyses*, Chap. VI.

Where the fossiliferous limestone emerges from beneath the level of the Allegheny river, a few miles above the mouth of the Kiskiminitas, the ore and buhr-stone are not discoverable. They occur, however, at the furnace of Mr. M'Nichols, $2\frac{1}{2}$ miles above Kittanning.— Here the ore overlies the limestone, in a band which in some places is two feet nine inches thick. The upper layers of the limestone are impregnated with more or less of the ore. This rock is of a buff color at its outcrop, effervescing freely when touched with an acid, and being full of various fossils. The buhr-stone or siliceous stratum, is found in detached beds, from six to eight yards in area, overlying the limestone. It is here a yellowish white flint.

Proceeding northward from this neighborhood, we have traced this ore in the river hills, between Red Bank and Mahoning creeks. The buhr-stone was also observed, overlying the fossiliferous limestone, at the mouth of Sugar creek, and also at the mouth of Bear creek, in the vicinity of Lawrenceburg. Eastward of the Allegheny river, the ore extends through Clarion county, the limestone rising to the surface of the country. This ferruginous bed, connected with the buhr-stone, supplies ore to Mill Creek, Webster, Beaver, Shippenville, Lucinda, Madison, and Clarion furnaces, in this county, and to Etna and Jackson furnaces, in Butler county. In Richland township, Clarion county, it is mined on the land of Mr. M'Ginnis. The ore here rests in immediate contact with the buhr-stone and limestone.— Its average thickness is fifteen inches, but in some places it is three feet. Between the ore and limestone, they often occur large cavities, some of which are several yards in extent, and from twelve to twenty inches deep. These seem to have been formed by the removal of the shale and other strata, by the gradual infiltration of the water from above. The overlying shale both here and in many other localities,

has been converted into a tough clay, in which the lumps of siliceous ore are imbedded.

The ore has been opened on the land of Mr. John Allsbach, in this neighborhood. The bed is there nine inches in thickness, and is partially interstratified with the flint, which occasionally renders it too siliceous to be profitably smelted. The rock breaks into large cuboidal masses of a grey, blue and yellow color, having spots and little seams of brown iron ore. These masses are occasionally much weather-eaten from the disintegration of the calcareous and softer portions. The overlying bed of ore varies from nine to eighteen inches in thickness.

About two miles south of Shippenville, the ore is mined at the "deal bank," belonging to Messrs. Shippen and Black, and to Myers & Co. The thickness of the ore averages two feet. It is a compact stratum, overlaid by blue shale and slaty sandstone. It is opened on the land of Blackstone, Long & Co., in the same neighborhood where it has a similar structure, though its thickness is unusually great. It here occurs in a solid bed about five feet in thickness, in one place becoming nine feet thick. It has an imperfectly cellular structure, and contains drusy cavities, some of which are filled with water. The material of the buhr-stone mingles itself in small quantities with the ore, and indeed the whole deposit is remarkably siliceous.

In Elk township, about a mile and a-half south of the turnpike, the ore is exposed on the lands of William Allsbach, Joseph Kutcher and others. At Kutcher's bank the bed varies from one to two and a-half feet in thickness. It is here chiefly of the spathose variety, being a semi-crystalline protocarbonate, of a grey and somewhat metallic aspect, and very heavy and compact. It breaks into large masses, consisting of the protocarbonate, surrounded by a crust of the peroxide, of a deep red color, which is usually an inch or more in thickness. One mile north of this locality, the limestone crops out on the surface of the ground, exhibiting itself in white and yellowish masses generally two or three feet in length.

The buhr-stone ore is wrought at Lucinda furnace, about eight miles north of Shippenville, and also in Pinegrove township, on the land of Mr. Henly, and others. At the former place it overlies the limestone, and varies in thickness from six to twenty-four inches. In some places the ore is replaced by the flint or buhr-stone. Much of it is of the cellular variety, the drusy cavities being often coated with a beautiful glaze, such as we behold in the hollow balls of ore found above the limestone, F. II. in the valleys of the Appalachian region of the State.

On the western side of the Clarion, in Paint creek township, the ore and buhr-stone are well exposed on the lands of Samuel Thomas, Daniel M'Naughton, and others. In the country south-east of that stream, the ore is exposed in many localities, and can be traced to the Jefferson county line. Its eastern and northern outcrop is governed by that of the limestone which it accompanies. Following it to the south-west we find it, after it passes under the river hill at Kittanning

reappearing on Buffalo creek, and there burying itself beneath the high grounds in the central parts of Butler county, to emerge again in Muddy creek, Slippery Rock, and Mercer townships. It is opened on the land of Judge Bouvard, four miles east of Centreville, where the bed is from six to twenty inches thick, the buhr-stone occasionally replacing the ore, and forming a bed which is here sometimes one foot thick, resting upon the limestone. The ore is wrought on the land of Mr. Buchanan, about two miles north of the above locality, where it and the buhr-stone are seen overlying the limestone. The ore is of excellent quality, and averages nine inches in thickness.

The great importance of this valuable deposit to the growing wealth and enterprise of the western part of the State, is beginning to be appreciated. I need hardly, therefore, dwell upon it any further than to mention the following circumstances in its favor. The richness of this ore, far exceeding that of the nodular variety common in the slates of the coal measures, will bear comparison with much of the best ore found in the limestone valleys south-east of the Allegheny mountain. Another merit is the facility with which it may be smelted either alone or when mixed with the nodular or ball ore, and particularly with the bog ore found so abundantly in Venango and Clarion counties. In the thicker parts of the deposit, it is a nearly pure semi-crystalline protocarbonate of iron, a variety well known to be susceptible of extremely easy reduction. It is moreover recommended by the readiness with which it can be traced, arising from its accompanying closely the fossiliferous limestone, which furnishes an excellent landmark. The buhr-stone assists the discovery of it in a still greater degree, the fragments of that peculiar stone being so easily recognized, serving to point out the position of the ore. Besides these important facts, it should be mentioned that a workable seam of coal occurs above the ore and limestone, and another beneath them at a moderate interval. The importance of this tripple association of the materials employed in the manufacture of iron, to the future wealth of our western counties must be obvious to every one who adverts to the incalculable advantage which Great Britain has derived from the same fortunate union.

No. 15.—Fossiliferous Limestone.

The stratum which next succeeds the buhr-stone in the descending order, is a compact bed of light blue limestone. Its upper layers are occasionally tinged yellow by the ferruginous infiltration from the overlying stratum. In other instances, the weathered surfaces are of a dark gray color. The limestone in certain localities is remarkably slaty, consisting of thin shivery layers. This peculiar aspect arises in part from its sandy composition, which impairs its cohesion. When it is of this kind, much care is requisite in converting it into lime, lest too intense a heat should vitrify it. Properly calcined it yields an excellent gray lime. It abounds in fossils, particularly of the genus *encrinite*, the round seams of which stand out from the weathered

surfaces of the rock. They are generally composed of crystalized rhombic carbonate of lime; and the characteristic fossil is a small species of *terebratula*, which in some places seems to constitute a large proportion of the rock. The teeth and other remains of *sarcoïd fishes* also exist in this stratum.

The limestone rises above the level of the Allegheny river, about four miles above the mouth of the Kiskiminitas. At this latter place it has been passed at the depth of one hundred feet in boring a salt well. At Kittanning it attains an elevation of one hundred and four feet above the river, being here ten feet in thickness. East of the river it is exposed along many of the tributary streams, particularly Crooked creek, where it measures seven feet in thickness. We find it on Red Bank creek, east of the village of New Bethlehem, and also well exposed on the land of Mr. Joseph Smith, where it lies near the water, in a bed ten feet thick. It re-appears west of Kittanning on Buffalo creek, and on Rough river, forming a conspicuous stratum fifteen feet in thickness.

Gradually rising as we advance up the Allegheny river, the limestone shows itself on the hills of Sugar creek, and is seen at the mouth of Bear creek at a height of several hundred feet above the water, capping the summits. From this point it stretches to the north-east, being traceable on both sides of Clarion river, until it reaches the western line of Jefferson county, beyond which we have not yet pursued it. Some striking and peculiar features mark the northern outcrop of this limestone, especially near the line of the northern turnpike. Rising with a gentle elevation from the south-west, it forms a series of insulated knobs, usually covered with a growth of chestnut and other deciduous trees, which contrast strongly with the surrounding evergreen foliage of the pine and hemlock. The position of the limestone in these knobs is plainly indicated, even to the eye of a superficial observer, by a little bench or terrace, caused by the washing away of the soft and underlying strata. These limestone knobs are numerous in Pine Grove, Elk Creek and Irvine townships, in Venango county. On the western side of the Allegheny river, the northern outcrop of the stratum is still more distinctly defined. It approaches within ten miles of Franklin, where it is exposed on the farm of Mr. Boner. It shows itself on Sugar creek, Bear creek and Buffalo creek, at a small elevation above these streams, westward of which it disappears under the hills of Butler county, coming again to the surface on Muddy creek and Slippery Rock. Near the former stream it may be seen on the lands of Mr. Jonathan Wriner, where it is accompanied by the buhr-stone, and is fifteen feet in thickness.

Slippery Rock and Mercer townships, in Butler county, being much lower than the township south of them, present a surface formed of this limestone and the strata which immediately overlie it. The bed is wrought in the neighborhood of Centreville and Harrisville, where it forms a series of low, flat ridges, similar in outline and structure to the hills which mark its outcrop in Clarion county. Rising gradually from the north-west corner of Butler county, it extends to the centre

of Mercer, its northern outcrop being traceable from the vicinity of Sandy lake, in a south-west direction, passing west of the town of Mercer, and thence onward until it reaches the State of Ohio.

This bed of limestone is exposed on the land of Mr. Porter, one mile from the town of Mercer, where it is between two and three feet thick, and rests directly in contact with an underlying seam of coal, which in other places is usually separated from it by a bed of shale. This locality is near the north-western limit of the stratum, which seems to thin out and disappear as we follow it towards the north-west. The rock is here slaty in its upper layers, and darker and heavier than usual. It has this same aspect at Sandy lake, ten miles N. N. E. of Mercer, on the margin of which the limestone is exposed in a dark and slaty seam, only fifteen inches thick, having a bituminous odor and abounding in fossils. It is overlaid by two seams of coal which have been opened. The upper one is five feet in thickness.

Three miles above New Castle, the limestone is exposed on the farms of Mr. Carpenter and others, where it occurs at a considerable elevation above the Neshannock. It is here a dark blue, very compact and fossiliferous rock, about ten feet in thickness. The stratum is again visible on the hills which overlook the Beaver river, about nine miles below New Castle, where it is ten feet in thickness, and has the singular shrivelled aspect which it presents on Crooked creek, in Armstrong county. It is also exposed at various other places in this vicinity. Descending the Beaver we may trace it finally to the Ohio river, where it is well exposed two miles below the borough of Beaver, in the form of a dark blue, fossiliferous stratum, twenty feet thick, which dips gently to the south-west. It here occurs at the base of the hills at a small elevation above the river; beneath which it finally disappears.

The wide range of this stratum, its value as a source of pure lime, and its importance as a guide to the overlying buhr-stone ore, are too obvious to require comment here. Its exact position may be readily ascertained by the inhabitants of the wide district over which it spreads, in almost every spot where it lies above the general water level of the country. It is only necessary to attend to the dimension or thickness of the strata here laid down, to identify some well characterized member of the series, and then to institute a simple measurement by a levelling instrument, giving the height or depth of the ascertained stratum, and we can infer with sufficient accuracy the situation at any place, both of this limestone and every other bed in the group. There are numberless points on both sides of the ravines, where the outcrop of the limestone is concealed by a slight covering of earth, where it could readily be detected if the farmer had a correct notion, such as the present report is intended to convey, of the true relative position of the strata, and their general range and dip. A little knowledge respecting the true place in the series of this limestone, will prove an invaluable guide to the coal, several seams of

which occur near it, in situations readily ascertained by calculation from the thickness here furnished. The average thickness of the limestone may be stated at fifteen feet.

No. 16. Shale.

Beneath the limestone rests a bed of shale of great importance, in an economical point of view, as it is the depository of a considerable amount of nodular *iron ore*. It has the usual aspect of the shale of the coal measures, and like nearly all of them, is occasionally replaced by layers of argillaceous sandstone. In such cases, the stratum acquires twice its usual thickness, becoming a mass of alternating layers of shale and slaty sandstone, separating the limestone from the underlying seam of coal. Tracing it in connection with the other members of the series, we find it well exposed at Allegheny furnace, two and a-half miles above Kittanning. It here embraces nine layers of nodules of the ore, in a thickness of twelve feet. These nodules vary in diameter from six to twelve inches. They are flattish, and of a lamellar structure. Ore of good quality occurs in this shale at various other places in the same section of country.

Ascending the Allegheny river, we meet with many localities where this stratum presents indications of the ore. Near Scrubgrass and Rockland furnaces, the ore is extensively worked. This shale merits indeed an attentive examination on the part of those interested in the development of iron ore. In many places the rock is between thirty and forty feet thick, when it contains much slaty sandstone. In the southern part of Venango county, especially in Irwine and Rockland townships, it does not exceed ten feet. The lower layers in contact with the coal, often contain vegetable impressions. The average thickness of the mass is twenty feet.

No. 17. Coal.

Underlying the preceding stratum, there occurs a vein of coal extending over a considerable tract of country. We find it slowly rising above the base of the river hills, above Kittanning, until it attains an elevation of several hundred feet near the mouth of Bear creek. It has been here mined to a small extent on the land of Mr. R. Leonard, the seam being three and a-half feet thick, and affording an excellent coal for fuel; under it there lies a bed of fire-clay, three feet in thickness. At Robinson's salt wells, eight miles lower down the Allegheny, this coal seam is worked to the height of two hundred and thirty-three feet above the river. East of the Allegheny and south of the Clarion, it is opened in many places. At the mouth of Schull's run, it crops out along the brow of the river hills at a still greater elevation than that above recorded. On the opposite side of the Allegheny, it is well exposed on the lands of Mr. Crawford and others. There is a seam of coal five feet in thickness opened in this neighborhood, on the lands of Mr. Coe and others, which, as far as we have

yet been able to determine, is the same bed as that now described. Over it lie three thinner layers of coal, each less than a foot in thickness, separated from each other by shale.

The coal bed we have been tracing, ranges through Irwine and Sandy creek townships, Venango county, where it is worked on the lands of Messrs. Wm. Cross, Joseph M'Kean ——— Boner and others. It here lies about twelve feet below the limestone. Rejecting a band of coal twenty inches thick, embraced in the overlying shale, the principal seam measures three and a-half feet in thickness. It can be traced east of the river throughout Venango and Clarion counties, as far as the boundary line of the latter, beyond which no examination has yet been made. It is well exposed in many places in Pine Grove and Farmington townships, as at Lucinda furnace, where it occurs about thirty feet below the limestone.

This seam of coal, in common with many other members of the series, appear to thin away towards the north-west as it approaches its outcrop, for in the vicinity of the town of Mercer we find it lying immediately below the limestone, and only three feet thick. At the north of Beaver river, there occurs a bed of coal near the level of the Ohio, the position of which, in relation to the overlying fossiliferous limestone, is identical with that of the present seam. Traced to the south-west, it sinks beneath the bed of the Ohio, in conformity with the general dip of all the coal measures in this neighborhood. The average thickness of this coal seam is four feet.

No. 18—Shale and Argillaceous Sandstone.

Immediately under the coal just described we find a bed of shale, sometimes passing gradually into a slaty argillaceous sandstone. The upper layers near the base of the coal frequently contain nodules of *iron ore*, which are sometimes from two to three feet in length, and of excellent quality. These seem to lie irregularly in the shale; the smaller nodules are more homogeneous in composition, compact and fine grained. Sometimes, however, they contain much sulphuret of iron and calcareous spar. The larger masses include generally an oblong somewhat cylindrical nucleus, which near the outcrop is surrounded by a concentric crust of peroxide of iron, of various degrees of fineness. This outer shell readily crumbles by exposure. Closely examined, these large nodules present a distinctly oolitic structure. Though of a coarse grain, derived from a large amount of earthy ingredients, they are freer from sulphur than the smaller and more compact nodules. The shale in which the ore most abounds, is of a yellow color, soft and friable, and belongs to the first eight feet below the coal.

In the lower layers of the general stratum, we sometimes find thin bands of coal and black bituminous shale, varying from three to ten inches in thickness. Care should be observed not to confound these with the regular continuous coal seams which we have enumerated as separate members of the series. Good iron ore is obtained from

the present stratum, in the vicinity of Rockland furnace, in Rockland township, Venango county.

When the sandstone layers increase in quantity and thickness, the iron ore becomes proportionately deficient. Separating the layers of sandstone, occur sometimes bands of soft bituminous shale, which resemble coal smut, and which frequently mislead the explorer after coal. The upper half of the stratum passes by decomposition into a bed of clay, showing but few traces of the original lamination of the shale. This contains some nodules of iron ore. The average thickness of the whole stratum is about forty feet.

No. 19. Coal.

Succeeding the above deposit of shale and sandstone, there occurs another seam of coal which we have traced over a considerable range of country. As its outcrop extends in a north-east and south-west direction through Mercer, Venango and Clarion counties, traversing a country where the rocks are much concealed by forest, we find the bed but very partially exposed. Its position, at a moderate depth below the limestone, greatly facilitates its detection. It will prove a valuable bed whenever the district which it occupies shall become thickly settled. It is the lowest workable coal seam hitherto found in the series along the Allegheny river, for, though numerous thin bands of coal occur in the slate beneath it, we have yet found more or them of sufficient size to merit a distinct enumeration. This layer of coal is opened on the farm of Mr. Joseph Brandon, six miles east of Franklin, where it lies on the summits of the hills, beneath the black bituminous shale. It here measures twenty inches in thickness, and is a kind of semi-cannel coal, light, of a slaty structure, and of a peculiar lustre. It somewhat resembles a soft black slate, but is a tolerably pure coal, burning freely, with considerable flame.

It is opened on the lands of Messrs. John W. How and E. Bratton in Rockland township, where it occupies the river hills. Here the layers succeed each other as follows :

Brown shale with ore,	....	..	....	..	8 feet
Coal,	..	....	..	....	4 inches.
Black shale,	..	....	..	....	1 "
Coal,	....	..	....	..	3 "
Black shale,	....	..	....	..	3 "
Coal,	....	..	....	..	18 "

The coal ignates readily, and resembles that above described. It lies several hundred feet above the river. This seam may be traced on the opposite side of the Allegheny, in Irwine township, Venango county, being opened on the land of Judge M'Kee, where it is about two feet in thickness, and rests on the bituminous shale. Thickness two feet.

FORMATION XII. *White Sandstone*

We have now arrived at the coarse and massive sandstone which constitutes the bottom of the productive coal measures, and which exercises a marked influence in the topography of the country.— Emerging from the level of the Allegheny river, above Kittanning, this stratum rises to a considerable height above the water, near the mouth of the Clarion, though it is covered by the overlying coal measures. In the neighborhood of Franklin, however, it caps the hills on both sides of the river, and forms the general surface of the country throughout the northern part of Venango.

In this section of the State, F. XII. is of a fine grained sandstone, consisting of minute rounded grains of quartz. Its prevailing color is a whitish gray, though it is often streaked and blotched with brown peroxide of iron. Where it is much exposed to the weather, it disintegrates into sand, the ferruginous matter being removed by solution. The whole mass consists usually of two solid beds of sandstone, the upper about fifteen feet, the lower about thirty feet in thickness. These are separated by layers of shale and slaty sandstone, variously alternating, which contain a considerable quantity of nodular iron ore. It is this formation, which, rising gradually from the south, forms the surface of those extensive glades or high barren planes, so common along the northern margin of the coal region. These glades are generally covered with a sparse and stunted growth of wood or other vegetation, sustained by a thin and sandy soil, which predominates, except where certain basin-shaped depressions of the surface have received the argillaceous matter derived from the shales. The sandstone may be readily discovered either rising in massive beds from beneath the soil, or forming thick ledges along the sides of the ravines and vallies. Though these rocks injure the agricultural character of this district, they are not without their merits, furnishing an admirable building stone, well suited for the construction of furnaces. The best variety of the sandstone for the in-walls of furnaces, is the soft and light gray kind, marked by minute circular blotches, of a brown or black color, imparting a variegated appearance to the rock. This is easily dressed, and resists the fire remarkably well.

Throughout the district in which this rock prevails, we find numerous and valuable deposits of *bog iron ore*. This material is generally precipitated from the waters of Chalybeate springs, which issue along the sides of the ravines, bringing with them the ferruginous particles of the sandstone and the pyritous shales in contact with it.

The extreme margin or outcrop towards the north, has not been accurately traced, except along the Allegheny river. It has been pursued to the north of Teonista creek, where we recognize a well marked stratum, belonging apparently to the bottom of the formation. This is a solid bed of fine grained gray and brownish sandstone, eight feet in thickness. It occurs at the height of fifty feet above the creek, and has the aspect in some places of a true conglomerate, some of its layers imbedding numerous rounded pebbles of white quartz. North

of the Teonista, a sandstone, supposed to belong to the same formation, is extensively met with, but the wilderness condition of the country there, has hitherto prevented its being minutely examined.— It is a white sandstone, in some places assuming the features of a conglomerate. On the opposite side, two miles south of the Tytiute creek, a coarse conglomerate is to be seen lying near the summits of the hills. This is traceable to the town of Warren, and is undoubtedly the principal member of F. XII., as it is developed in this part of the country. Ascending French creek, we find this stratum constituting the summits of the hills until we arrive at Meadville. West of the Allegheny river, the rock is extensively developed, being exposed along the Shenango river from Greenville to Sharon and New Castle, affording in many places a superior building stone for the construction of locks, bridges, &c., on the public works. The exact range of this formation will be ascertained during the approaching season. Its average thickness is about one hundred feet.

Rocks below Formation XII.

Beneath the rocks above described, we find on the Allegheny river and its tributaries, a series of well defined strata, consisting of shales and thinly bedded argillaceous sandstones, variously interstratified. The thin arenaceous layers are generally from two to ten inches thick, light blue, fine grained and micaceous, and splitting into neat flags. Other layers contain vegetable impressions, beautiful specimens of which, especially of the *genus fucoides*, abound in this rock. Many of these thin flaggy sandstones exhibit "ripple marks," possessing great breadth and regularity of form. The shales are generally dark colored and soft, and contain thin seams of *iron ore*, identical with that of the coal measures. Thin beds of impure coal have likewise been met with in the upper layers, but no workable stratum is known.

The rocks here mentioned, compose the river hills in the neighborhood of Franklin, where they underlie the thick sandstone above described. They are well exposed along most of the streams of the northern half of Venango county. We have traced them also up the Allegheny river to the mouth of Teonista creek, and up French creek as far as Meadville. On the Shenango and the neighboring streams, they are again met with. The arenaceous limestone described in my last annual report, as a bed two feet in thickness, is a member of this series, and retains its characteristic features over a great range of country, with remarkable constancy,

Our investigations during the past year, not being particularly directed to the country occupied by these lower rocks, it is useless to attempt, at present, a more detailed description. They will be discussed minutely in a subsequent publication.

CHAPTER VI.

Composition of the Iron Ores referred to in this Report.

For the purpose of comparison, and for the sake of convenient reference, I have deemed it best to assemble under one chapter, the various analyses of iron ores referred to in the body of this report, adding some others not specifically alluded to, which belong to formations and localities described in my former annual publications. It will be seen from the list here presented, that this State is remarkable, no less for the singular variety of its iron ores, than for the extraordinary abundance in which some of these prevail. The limited scope of an annual report, and the necessity for more time to complete various branches of research, relating to our ores and the kinds of iron which they are generally best adapted to produce, compel me to defer entering for the present, upon a number of highly useful practical topics suggested by the analytical details here introduced. In the mean while, however, it will interest those who are in any manner connected with the development of working of our ores, to find the exact composition and relative richness and purity of a large number of them thus displayed.

It will contribute to clearness of arrangement, and at the same time materially assist us hereafter in arriving at useful general laws, concerning the intimate connections which subsist between the geological situation of these ores and their chemical nature, if we classify their analyses here given, according to the formations in which the ores are found. I shall commence, however, with the specimens derived from the primary rocks, and then present those of the various secondary formations, following the ascending order.

SECTION. I.

Analyses of Iron Ores from the primary rocks of the south-eastern district of the State.

TITANIFEROUS IRON ORE from near Isabella Furnace, on the East Branch of Brandywine creek, Chester county. This ore occurs as a vein in gneiss rock.

DESCRIPTION.

The specimen is of a black color ; lustre metallic ; cleavage foliated, sometimes granular ; has magnetic polarity.

Specific gravity,

4.95

COMPOSITION IN 100 PARTS :

Titanic acid,	....	..	....	..	22.39
Protoxide of iron,	..	..	..	..	76.86
Loss,	....	....	....	..	75
					<hr/>
					100.00
					<hr/>

This specimen contains 59.44 per cent. metallic iron.

IRON ORE from the Yellow Springs, Chester County.

DESCRIPTION.

The specimen exhibits the usual appearance of brown hematitic iron ore, but has a resinous lustre. It occurs in a ferruginous loam, overlying the gneiss.

COMPOSITION IN 100 PARTS :

Peroxide of iron,	....	..	....	..	82.91
Alumina,	....	..	....	..	1.35
Water,	..	....	..	....	13.90
Silica and insoluble matter,	..	....	..	....	3.32
					<hr/>
					101.48
					<hr/>

The proportion of metallic iron in this specimen is 57.55 per cent.

SECTION II.

Analyses of Iron Ores of Formation I.

IRON ORE from Chesnut Hill, near Columbia, Lancaster County.

DESCRIPTION.

Brown; compact; surface mammillary; outer portions of the mass crystalline and radiated. The analysis was performed upon a piece representing the average of the mass.

COMPOSITION IN 100 PARTS :

Peroxide of iron,	..	....	..	....	84.39
Alumina,	....	..	....	..	2.46
Silica and insoluble matter,	..	....	..	....	2.38
Water,	..	....	..	....	10.99
					<hr/>
					100.22
					<hr/>

The metallic iron amounts to 58.51 per cent.

IRON ORE from Susan Ann Furnace, York County

DESCRIPTION.

Blackish brown; micaceous, and sandy.

COMPOSITION IN 100 PARTS :

Peroxide of iron,	40.71
Peroxide of manganese,	8.91
Alumina, (phosphate),	2.84
Insoluble matter, including phosphoric acid, ..	39.56
Water,	7.98
	<hr/>
	<u>100.00</u>

This specimen contains 28.23 per cent. metallic iron.

IRON ORE from M. G. Ege's Mountain Bank, South of Carlisle Iron Works, Cumberland County.

DESCRIPTION.

Amorphous; color, dull bluish-brown; powder, brown; texture, friable; aspect, earthy.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	20.10
Alumina,	0.10
Peroxide of iron,	49.80
Peroxide of manganese,	17.55
Water,	12.00
Loss,	0.45
	<hr/>
	<u>100.00</u>

This specimen contains 33.86 per cent. metallic iron.

IRON ORE from a Bank half a mile from Carlisle Iron Works, M. G. Ege's.

DESCRIPTION.

Dull black color; lustre somewhat metallic; sub-crystalline; slightly magnetic: has some resemblance to the ores of the Warwick and other mines adjacent to trap dykes.

COMPOSITION IN 100 PARTS :

Magnetic oxide of iron,	..	..	..	64.79
Peroxide of iron,	..	..	..	27.93
Oxide of Managanese,	..	....	....	a trace
Alumina,	....	..	....	a trace
Silica and insoluble matter,	....	..		3.30
Water,	....	..	....	3.81
				<hr/>
				99.83
				<hr/>

This ore contains 65.88 per cent. metallic iron.

IRON ORE from the Mountain Ore Bank of Carlisle Iron Works.

DESCRIPTION.

Brown; mottled; somewhat cellular; locally called "honey-comb ore."

COMPOSITION IN 100 PARTS :

Peroxide of iron,	....	....	....	70.04
Peroxide of manganese,	..	..	..	3.32
Alumina,	..	....	....	a trace
Silica and insoluble matter,	....	..		16.32
Water,	..	..	....	10.96
				<hr/>
				100.64
				<hr/>

This specimen contains 48.56 per cent. metallic iron.

IRON ORE from General T. C. Miller's Mountain Bank, Cumberland Furnace, Cumberland county.

DESCRIPTION.

Brown hemetite; botryoidal on the surface, and somewhat porous; color of mass orchrey.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	..	..	12.0
Alumina,	....	....	....	0.4
Peroxide of iron,	..	..	..	74.8
Water,	..	....	..	12.0
Loss,	....	....	....	0.8
				<hr/>
				100.0
				<hr/>

This specimen contains 52.36 per cent. metallic iron.

IRON ORE from Peffer's Bank, six miles south-west of Carlisle, Cumberland county

DESCRIPTION.

Amorphous, compact; color dark brown; interspersed with light colored ocherous matter.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	..	..	12.1
Alumina,	..	..	...	4.3
Peroxide of iron,	..	...	..	69.4
Water,	..	...	..	14.0
Loss,	....	....	....	0.2
				<u>100.0</u>

This specimen contains 48.58 per cent. metallic iron.

IRON ORE one mile and three-fourths from Carlisle Iron Works, Cumberland county.

DESCRIPTION.

Pipe ore; pipes small; color dark chesnut brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	.	.	..	4.05
Alumina,	....	....	..	a trace
Peroxide of iron,	....	....	..	85.65
Water,	....	..	..	8.80
Loss,	....	..	....	0.90
				<u>100.00</u>

This specimen contains 59.95 per cent. metallic iron.

IRON ORE from Pond Bank, used at Caladonia Furnace, Stevens and Paxton's, Franklin county.

DESCRIPTION.

Hematitic; imperfectly crystallized; form rounded; color dark chesnut brown. Specimen consists of a fragrant of a hollow spherical ball.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	....	9.30
Alumina	....	trace
Peroxide of iron.	....	79.05
Water	....	12.00
		<hr/>
		100.35
		<hr/>

This specimen contains 55.33 per cent. metallic iron.

IRON ORE from the Hill Bank used at Southampton Furnace, Franklin county, (better portion.)

DESCRIPTION.

Texture cellular ; surface of cells sometimes lined with crystalized hematite ; color dark chesnut brown.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	....	5.90
Alumina,	....	2.70
Peroxide of iron,	....	78.85
Maaganese,	....	trace
Water,	....	12.50
Loss,	....	0.05
		<hr/>
		100.00
		<hr/>

This specimen contains 55.19 per cent metallic iron.

IRON ORE from the Hill Bank, used at Southampton Furnace, Franklin county, (inferior portion.)

DESCRIPTION.

Amorphous, cellular, dark brown alternating with light colored matter.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	....	5.80
Alumina,	....	1.80
Peroxide of iron,	....	76.30
Manganese,	....	1.00
Water,	....	14.50
Loss,	....	0.60
		<hr/>
		100.00
		<hr/>

This specimen contains 53.41 per cent. metallic iron.

IRON ORE from Montalto Furnace, Hughes' Franklin county,
(Lower Ore.)

DESCRIPTION.

Texture cellular; color, dark chesnut brown; walls of cells compact, interior occupied by light colored ochreous matter.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	....	..	7.0
Alumina,	..	....	3.3
Peroxide iron,	....	..	75.2
Water,	....	..	14.0
Loss,	..	....	0.5
			<u>100.0</u>

This specimen contains 52.64 per cent. metallic iron.

IRON ORE from Montalto Furnace, Franklin county, (Upper Ore.)

DESCRIPTION.

Mottled brown and ochrey; in some parts compact; in others soft and cellular, and distinctly laminated.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	....	..	13.3
Alumina,	..	....	2.5
Peroxide of iron,	..	....	71.0
Water,	....	..	12.6
Loss,	..	....	0.6
			<u>100.0</u>

This specimen contains 49.70 per cent. metallic iron.

IRON ORE from a Bank one mile southwest from Hughes' Forge,
Franklin county.

DESCRIPTION.

Texture, compact; massive; color, dark brown; aspect of fresh surface somewhat resinous.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	.....	2.80
Alumina,	.....	1.40
Peroxide of iron,	.....	79.10
Sesqui oxide of manganese,	.....	4.00
Water,	.....	12.00
Loss,	.....	0.70
		<u>100.00</u>

This specimen contains 55.37 per cent. metallic iron.

IRON ORE use at Pond Furnace, (Moore's,) Franklin County.

DESCRIPTION.

Impure hydrated oxide; texture, hæmatitic; semi-crystalline on surface, which is covered with mammillary protuberances; color of mass, brownish yellow—of surface, dark brown.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	....	..	10.0
Alumina,	....	..	....	2.6
Peroxide of iron,	....	..	....	73.5
Manganese,	....	..	....	a trace
Water,	...	..	....	13.0
				<hr/>
				99.1
				<hr/>

This specimen contains 51.35 per cent. metallic iron.

SECTION III.

Analyses of the Iron Ores of the Limestone Formation II.

IRON ORE from Miller's Mine, four miles North-West of Allentown, West side of the Lehigh River, Lehigh County.

DESCRIPTION.

Brown; stalactitic; variety, "pipe ore;" the cavities partly filled with pulverulent yellow oxide of iron.

COMPOSITION IN 100 PARTS :

Peroxide of iron,	....	..	....	..	86.59
Alumina,	....	..	....	..	a trace
Silica and insoluble matter,	..	....	..	..	3.08
Water,	....	..	....	..	11.31
					<hr/>
					100.98
					<hr/>

This specimen contains 60.04 per cent. metallic iron.

IRON ORE from Balliat's Mine, five miles North-West of Allentown, Lehigh County.

DESCRIPTION.

Color, liver brown; compact; superficial portion crystalline, radiated, and mammillary. The latter part was selected for analysis.

COMPOSITION IN 100 PARTS:

Peroxide of iron,	83.22
Alumina,	0.21
Silica and insoluble matter,	4.81
Water,	12.40
	<hr/>
	100.64
	<hr/>

This specimen contains 57.61 per cent. metallic iron.

IRON ORE from Ballhat's Mine, five miles North-West of Allentown, Lehigh County.

DESCRIPTION.

Color, reddish brown; structure, lamellar; compact.

COMPOSITION IN 100 PARTS:

Peroxide of iron,	84.00
Alumina,	1.00
Silica and insoluble matter,	6.50
Water,	9.50
	<hr/>
	101.00
	<hr/>

This specimen contains 58.24 per cent. metallic iron.

IRON ORE from Daniel Shwartz's Mine, half a-mile South-West of Emaus, Lehigh County.

DESCRIPTION.

Dark brown; compact; lustre somewhat metallic.

COMPOSITION IN 100 PARTS:

Peroxide of iron,	79.64
Alumina,	a trace
Silica and insoluble matter,	9.05
Water,	11.40
	<hr/>
	100.09
	<hr/>

This specimen contains 55.22 per cent. metallic iron.

IRON ORE from a Bank, one mile West of Trexlerstown, Lehigh County.

DESCRIPTION.

Brown; compact; stalactitic; of the structure usually termed "pipe ore."

COMPOSITION IN 100 PARTS :

Peroxide of iron,	....	..	....	87.12
Alumina,	..	....	.. ..	0.40
Silica and insoluble matter,	....	....		2.80
Sulphur,	..	..	.. ..	a trace
Water,	....	...	....	10.90
				<hr/>
				100.72
				<hr/>

This specimen contains 61.03 per cent. metallic iron.

IRON ORE from the Moselem Mine, near Eskhard's Mill, four miles South-West of Kutztown, Berks County.

DESCRIPTION.

Dark, dull brown; compact.

COMPOSITION IN 100 PARTS :

Peroxide of iron,	....	....	....	77.20
Alumina,	..	..	....	2.60
Silica and insoluble matter,	..	..		8.90
Water,	....	....	....	11.00
				<hr/>
				99.70
				<hr/>

This specimen affords 53.53 per cent. metallic iron.

IRON ORE from Gorgas's Bank, three and a-half miles South-West from Harrisburg,—Cumberland County.

DESCRIPTION.

Structure, hematitic; geodiferous; internal surface of goedes covered with a light brown incrustation; color of mass, dark brown.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	....	....		4.80
Alumina,	..	..	....	2.72
Peroxide of iron,	..	....	..	77.20
Manganese,	..	..	....	a trace
Water,	..	..	....	15.15
Loss,	....	....	..	0.13
				<hr/>
				100.00
				<hr/>

This specimen contains 54.04 per cent. metallic iron.

IRON ORE from Kerr's Fields, eight miles west from Carlisle.

DESCRIPTION.

Structure tending to laminated; color, dark chesnut brown; compact.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	....	....	13.0
Alumina,	..	..	4.8
Peroxide of iron,	....	..	69.0
Water,	..	....	13.0
Loss,	..	..	0.2
			<hr/>
			100.0
			<hr/>

This specimen contains 48.03 per cent. metallic iron.

IRON ORE used at Cumberland Furnace, Gen. T. C. Miller's, occurs one and a half miles from Furnace, in Limestone—Cumberland county.

DESCRIPTION.

Structure, slender pipes; color, chesnut brown; compact.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	..	3.89
Alumina,	....	..	....	2.50
Peroxide of iron,	..	....	..	84.60
Lime,	....	....	..	a trace
Water,	..	....	..	8.70
Loss,	..	....	..	0.31
				<hr/>
				100.00
				<hr/>

This specimen contains 59.22 per cent. metallic iron.

IRON ORE from the Helm Bank, used in Mary Ann Furnace; Whitehill and Ellis's, Cumberland county.

DESCRIPTION.

Structure, somewhat cellular; surface covered with small mammillary protuberances.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	5.8
Alumina,	2.0
Peroxide iron,	77.2
Water,	14.5
Loss,	0.5
	<u>100.00</u>

This specimen contains 54.04 per cent. metallic iron.

IRON ORE from the Clippinger Bank, used at the Mary Ann Furnace,
Cumberland county.

DESCRIPTION.

Structure, large columnar ; pipes, stalactitic ; compact in centre ; on surface, cellular ; color, bright chesnut brown.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	2.60
Alumina,	50
Peroxide iron,	87.09
Water,	8.81
Loss,	1.00
	<u>100.00</u>

This specimen contains 60.96 per cent. metallic iron.

IRON ORE from the Clippinger Bank, used at the Mary Ann Furnace,
Cumberland county.

DESCRIPTION.

Structure, numerous pipes closely cemented together ; color, rich chesnut brown, with a slightly blue tinge.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	4.9
Alumina,	6
Peroxide iron,	84.6
Manganese,	a trace.
Water,	8.95
Loss,	0.95
	<u>100.00</u>

This specimen contains 59.02 per cent. of metallic iron.

IRON ORE from the Kressler Bank, used in Southampton Furnace, Franklin county.

DESCRIPTION.

Amorphous, cellular, somewhat laminated; color brown mottled.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	..	..	9.0
Alumina,	..	..	..	2.9
Peroxide of iron,	....	....	....	75.0
Manganese,	..	....	..	a trace
Water,	....	..	..	13.0
Loss,	.	....	..	0.1
				<hr/>
				100.0
				<hr/>

This specimen contains 52.5 per cent. metallic iron.

IRON ORE from the Rail road Bank used at the Southampton Furnace, Franklin County.

DESCRIPTION.

Structure cellular; color brown: compact.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	....	....	14.7
Alumina,	..	....	0.8
Peroxide of iron,	..	..	72.0
Manganese,	....	..	a trace
Water,	...	....	12.0
Loss,	..	....	0.5
			<hr/>
			100.0
			<hr/>

This specimen contains 50.4 per cent. metallic iron.

IRON ORE from the old diggings at Pilgrim Bank, north-east from Shippensburg.

DESCRIPTION.

Structure closely adhering pipes so as to be almost obliterated; color dark chesnut brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	..	..	6.8
Alumina,	..	..	....	4.0
Peroxide of iron,	..	..	..	77.7
Water,	..	..	....	11.0
Loss,	....	....	....	5
				<hr/>
				100.0
				<hr/>

This specimen contains 54.39 per cent. metallic iron.

IRON ORE from the Roxbury Bank, west of Shippensburg, Franklin County.

DESCRIPTION.

Pipe ore, the pipes adhering closely, composed of an intermixture of a compact chesnut brown oxide, with a light colored ochreous substance.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	..	.	9.3
Alumina,	....	....	....	3.6
Peroxide of iron,	..	..	..	75.1
Water,	..	....	..	12.0
				<hr/>
				100.0
				<hr/>

This specimen contains 52.57 per cent. metallic iron.

IRON ORE from the Green Village Bank, Stevens and Paxton's, Franklin county.

DESCRIPTION.

Structure, long slender pipes of uniform texture throughout; color brownish yellow.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	....	....	4.2
Alumina,	...	....	0.9
Peroxide of iron,	..	..	82.6
Water,	....	....	12.0
Loss,	....	..	0.3
			<hr/>
			100.0
			<hr/>

This specimen contains 57.82 per cent. metallic iron.

IRON ORE from Heifner's Bank, used in Caledonia Furnace, Stevens and Paxton's, Franklin county.

DESCRIPTION.

Hydrated oxide ; color, bright chesnut brown ; compact.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	....	..	10.8
Alumina,	....	..	....	a trace.
Peroxide iron,	..	....	..	76.6
Manganese,	....	..	....	a trace.
Water,	....	..	....	12.5
Loss,	..	....	..	0.1
				<hr/>
				100.0
				<hr/>

This specimen contains 53.62 per cent. metallic iron.

IRON ORE from near Heifner's, six miles from Caledonia Furnace, Franklin county.

DESCRIPTION.

Structure; pipes closely adhering ; color, distinct brown.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	....	..	6.7
Alumina,	..	....	..	a trace.
Peroxide of iron,	..	....	..	81.6
Water,	....	..	....	11.4
Loss,	..	....	..	0.3
				<hr/>
				100.0
				<hr/>

This specimen contains 57.12 per cent. metallic iron.

IRON ORE from Middauer's, three miles north-east of Waynesburg, Franklin county.

DESCRIPTION.

Massive compact ; fracture, slightly conchoidal ; lustre, somewhat resinous ; color, brownish red, with a slight bluish tinge.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	..	....	14.0
Alumina,	....	..	....	0.5
Peroxide iron,	....	..	....	72.6
Manganese,	..	....	..	a trace.
Water,	....	..	....	12.5
Loss,	..	.	.	0.4
				<hr/>
				100.0
				<hr/>

This specimen contains 50.82 per cent. metallic iron.

IRON ORE from M'Dowell's Bank, five miles north-east from Mercersburg, Franklin county, (called garlic ore.)

DESCRIPTION.

Amorphous ; cellular ; color, bright brown.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	....	4.80
Alumina,	....	..	1.50
Peroxide of iron,	..	....	83.60
Manganese,	....	..	a trace.
Arsenic,	..	....	a trace.
Water,	....	..	9.40
Loss,	..	....	0.70
			<hr/>
			100.00
			<hr/>

This specimen contains 58.82 per cent. of metallic iron, and possesses a trace of arsenic.

IRON ORE from Carrick Furnace, Path Valley, Franklin county.

DESCRIPTION.

Structure, nodular ; surface, mammillary ; with interspersed argillaceous specks.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	.	..	....	17.40
Alumina,	..	..	....	5.80
Peroxide of iron,	....	....	....	59.50
Peroxide of manganese,	.	..	....	8.30
Water,	....	....	....	8.80
Loss,	....	....	..	0.20
				<hr/>
				100.00
				<hr/>

This specimen contains 41.65 per cent. metallic iron.

IRON ORE from Carrick Furnace, Path Valley, Franklin county.

DESCRIPTION.

Structure, cellular; interior of the cells coated with a buff colored ochreous deposit; color, dark chesnut brown; called "honey-comb ore."

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	3.80
Alumina,	2.25
Peroxide of iron,	84.30
Water,	8.85
Loss,	0.80
	<hr/>
	100.00
	<hr/>

This specimen contains 59.01 per cent. metallic iron.

IRON ORE from the Bull Bank of Pennsylvania Furnace, Centre county.

DESCRIPTION.

Hematitic; somewhat mottled; compact; fracture, conchoidal; color, chocolate brown.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	2.30
Alumina,	a trace
Peroxide of iron,	86.40
Manganese,	a trace
Water,	11.00
Loss,	0.30
	<hr/>
	100.00
	<hr/>

This specimen contains 60.48 per cent. metallic iron.

IRON ORE from Old Pennsylvania Furnace Bank, Centre county.

DESCRIPTION.

Pipe ore; the pipes small and closely set; color a dark chesnut brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	..	5.3
Alumina,	..	..	a trace
Peroxide of iron,	..	..	82.2
Oxide of manganese,	..	..	a trace
Water,	....	..	12.0
Loss,	....	..	0.5
			<hr/>
			100.00
			<hr/>

This specimen contains 57.54 per cent. metallic iron.

IRON ORE from the Pennington Bank, two and a-half miles South-West of Warrior Mark town, Huntingdon county.

DESCRIPTION.

Hematitic; cellular and slightly columnar; color, rich chesnut brown; surface of fresh fracture of a velvet-like lustre.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	8.8
Alumina,	....	..	0.5
Peroxide of iron,	..	..	75.2
Manganese,	..	....	a trace
Lime,	....	..	a trace
Water,	..	....	15.0
Loss,	....	..	0.5
			<hr/>
			100.0

This specimen contains 52.64 per cent. metallic iron.

IRON ORE from Springfield Furnace Ore Bank, Morrison Cove, Huntingdon county.

DESCRIPTION.

Structure, cellular; interior of cells coated with blue-black incrustation; color, dark chesnut brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	4.8
Alumina,	....	..	0.3
Peroxide of iron,	....	..	79.6
Sesqui-oxide of manganese,	..	....	3.0
Lime,	....	..	a trace
Water,	..	....	12.0
Loss,	....	..	0.3
			<hr/>
			100.0

This specimen contains 55.72 per cent. metallic iron.

IRON ORE from Bomb-Shell Bank, of Rebecca Furnace, Morrison Cove, Huntingdon county.

DESCRIPTION.

A section of hollow geode or bomb, hematitic fibrous crystalline, inner surface botryoidal, and iridescent.

COMPOSITION IN 100 PARTS:

Peroxide of iron,	....	..	....	..	84.22
Oxide of manganese,	....	..	....	....	0.41
Alumina,	....	..	....	..	0.65
Silica and insoluble matter,		..	....		6.43
Water,	..	....	..	....	8.25
					<hr/>
					99.95
					<hr/>

The proportion of metallic iron in this ore is 58.95 per cent.

IRON ORE from the Red Bank, three miles south-west of Rebecca Furnace, Morrison's Cove, Huntingdon county.

DESCRIPTION.

Texture, compact and close grained, somewhat jaspery; fracture slightly conchoidal; color bright reddish brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	..	..	..	32.1
Alumina,	....	....	....	....	a trace
Peroxide of iron,	..	..	....	..	57.2
Lime,	....	....	..	....	a trace
Water,	....	....	....	..	9.8
Loss,	....	....	....	....	0.9
					<hr/>
					100.0
					<hr/>

This specimen contains 40.04 per cent. metallic iron.

IRON ORE from Sarah Furnace Ore Bank, four miles south of M'Kee's Gap, Morrison's Cove, Bedford county.

DESCRIPTION.

Blackish brown; cellular; with concentric layers of denser crystalline fibrous hematite.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	11.7
Alumina,	....	..	a trace.
Peroxide of iron,	....	..	76.5
Manganese,	..	....	a trace.
Water,	....	..	11.6
Loss,	..	....	0.2
			<hr/> <hr/> 100.0

This specimen contains 53.55 per cent. metallic iron.

SECTION VI.

Analyses of Iron Ores of Formation III. (Slate.)

IRON ORE from the south side of Lowrey's Knob; Hanover Ore Bank, two and a-half miles north-east of Hanover Furnace, Bedford county.

DESCRIPTION.

Compact; brittle semi-crystalline; color, dark chocolate brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	2.80
Alumina,	....	..	3.20
Peroxide of iron,	..	....	80.20
Manganese,	....	..	a trace
Water,	..	....	12.90
Loss,	....	..	0.90
			<hr/> <hr/> 100.00

This specimen contains 56.14 per cent. metallic iron.

IRON ORE from the Hanover Ore Bank.—Kind chiefly used at the Furnace.

DESCRIPTION.

Compact; fracture conchoidal; color dull brown; surface in patches, coated with a greenish black shining incrustation.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	11.5
Alumina,	2.0
Peroxide of iron,	73.6
Manganese,	a trace.
Water,	11.5
Lime,	a trace.
	<hr/>
	98.6
	<hr/>

This specimen contains 51.52 per cent. metallic iron.

IRON ORE from M'Naughton's, one and a-half miles west from Mer-
cersburg, Franklin county.

DESCRIPTION.

A bog ore; dull brown, and cellular. It overlies the slate F. III.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	9.20
Alumina,	0.73
Peroxide of iron,	69.60
Water,	20.00
Loss,	0.47
	<hr/>
	100.00
	<hr/>

This specimen contains 48.72 per cent. metallic iron.

SECTION V.

Analyses of Iron Ores of Formation V.

IRON ORE from the Sandstone ridge, north-west side of Little Cove,
four and a-half miles north of Warren Iron Works, Franklin coun-
ty. (Specimen taken near the surface.)

DESCRIPTION.

Structure, slightly porous; laminated; fossiliferous; color, red-
dish brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	....	....	5.3
Alumina,	..	....	6.0
Peroxide of iron,	..	....	83.0
Manganese,	..	..	a trace
Lime,	....	....	0.5
Water,	....	..	5.1
Loss,	....	..	0.1
			<hr/> 100.00

This specimen contains 58.1 per cent. metallic iron.

Locality.—North-west side of Dickey's mountain, half a mile south of Lower Hanover Forge, Bedford county.

DESCRIPTION.

Structure, laminated; texture, earthy; color, dark chesnut brown, in some parts, almost black.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	..	39.3
Alumina,	....	....	a trace
Peroxide iron,	....	..	52.0
Manganese,	..	....	a trace
Water,	..	....	9.0
			<hr/> 100.3

This specimen contains 36.4 per cent. metallic iron.

IRON ORE from Matilda Furnace, two miles north-west of Newton Hamilton, Huntingdon county. (Upper division of the fossiliferous ore.)

DESCRIPTION.

Reddish brown, speckled with scales of grey micaceous oxide; cellular, from the removal of numerous minute fragments of fossils; breaks into rectangular pieces; streak red.

Specific gravity, 3.50.

COMPOSITION IN 100 PARTS:

Peroxide of iron,	..	..	74.76
Alumina,	..	....	5.06
Lime,	....	..	1.35
Manganese,	..	....	a trace
Silica and insoluble matter,	....	..	13.04
Undetermined matter,	..	..	2.11
Water,	..	....	3.82
			<hr/> 100.14

This specimen contains 51.84 per cent metallic iron.

IRON ORE from Matilda Furnace.—(Lower division of the same bed.)

DESCRIPTION.

Brown, with a rectangular fracture; consists of coarse grains of siliceous sand, cemented by brown oxide of iron.

COMPOSITION IN 100 PARTS:

Peroxide of iron.	....	..	....	44.07
Manganese,	....	....	....	a trace
Alumina	....	..	....	1.39
Lime,	..	....	....	0.49
Silica and insoluble matter,	.	....	....	52.33
Water	....	...	....	2.62
				<hr/>
				100.90
				<hr/>

This specimen contains only 30.56 per cent. metallic iron. It is so highly siliceous as to make the smelting of it unprofitable.

IRON ORE used at Hopewell Furnace, from a vein on Dr. Andrew M'Dowell's land, found on the bank of Yellow creek, in Lick Hill, Woodcock Valley, Bedford county.

DESCRIPTION.

Structure, highly fossiliferous; particles of carbonate of lime disseminated through the mass; color, a pale red.

COMPOSITION IN 100 PARTS:

Peroxide of iron,	....	..	....	}	46.50
Carbonate of the protoxide,	..	..	..
Alumina,	..	....	....		4.80
Carbonate of lime,	....	..	..		31.01
Silica and insoluble matter,	....	..	..		16.30
Water,	..	..	....		1 00
					<hr/>
					99.61
					<hr/>

From 39.60 per cent. of peroxide of iron obtained in the analysis, the amount of metallic iron in this specimen, is, by calculation, 27.72.

IRON ORE used at Hopewell Furnace, *softest kind*, obtained from upper vein two miles from the Furnace, Bedford county.

DESCRIPTION.

Texture, brittle and crumbly; disposed to break into irregular rhomboidal masses; color in mass, brown—of powder, rich purple brown; micaceous oxide sparsely disseminated throughout the mass; fossiliferous.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	.	..	..	13.85
Alumina,	....	....	....	4.50
Peroxide of iron,	....	..	..	78.05
Sesquioxide of manganese,	....	....		0.68
Lime,	..	..	..	a trace
Water,	....	..	..	3.00
				<hr/>
				100.28
				<hr/>

This specimen contains 54.95 per cent. metallic iron.

IRON ORE used at Hopewell Furnace *compact kind*, obtained from upper vein, two miles from the Furnace.

DESCRIPTION.

Texture, compact; color of mass, reddish grey—of powder, light brown; structure, micaceous; fossiliferous.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	....	....	8.8
Alumina,	....	.	....	1.0
Peroxide of iron,	..	....	..	55.2
Peroxide of manganese,	..	..	..	0.5
Lime,	..	....	..	17.6
Carbonic acid,	....	....	..	13.8
Water,	..	....	..	2.5
Loss,	....	....	....	0.6
				<hr/>
				100.0
				<hr/>

This specimen contains 38.64 per cent. metallic iron.

IRON ORE from the principal opening in the hill between Barre Forge and the Little Juniata, Huntingdon county—(lower portion of the vein.)

DESCRIPTION.

Structure, crystalline; distinctly fossiliferous; color, reddish grey calcareous.

COMPOSITION IN 100 PARTS:

Silica, ....	....	....	....	....	3.00
Alumina, .. ..	..	..	..	....	0.50
Peroxide of iron, ....	..	....	..	....	43.55
Proto-carbonate of iron, ....	....	....	..	....	3.56
Sesquioxide of manganese, .. ..	..	..	..	....	0.50
Carbonate of lime, ....	....	....	..	....	46.76
Water, ... ..	....	..	....	..	1.50
					<hr/>
					99.37
					<hr/>

This specimen contains 32.2 per cent. metallic iron.

IRON ORE from near Little Juniata, at Barre Forge, North-East of the Forge—(average specimen of the vein.)

DESCRIPTION.

Compact; breaks into rectangular plates; color, reddish grey; micaceous.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter, ..	....	..	7.50
Alumina, ....	..	....	1.40
Protoxide of iron, .. ..	..	..	57.00
Peroxide of manganese, ....	..	....	0.60
Lime, .. ..	....	....	18.00
Carbonic acid, .. ..	....	..	14.10
Water, .. ..	..	....	2.00
			<hr/>
			100.60
			<hr/>

This specimen contains 39.9 per cent. metallic iron.

SECTION VI.

Analyses of Iron Ores of Formation VI.

IRON ORE from Allegheny Furnace Ore Bank, six miles from Tuckahoe, Huntingdon county. This ore comes from near the contact of F. VI. and F. VII.

DESCRIPTION.

Amorphous; compact; brittle; fracture earthy; color, dark bluish brown.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	..	..	6.0
Alumina,	....	..	....	a trace
Peroxide of iron,	..	..	..	82.2
Peroxide of manganese,	....	..	....	8.0
Water,	....	..	....	4.0
				<hr/>
				100.2
				<hr/>

This specimen contains 57.54 per cent. metallic iron.]

IRON ORE from Allegheny Furnace, six miles from Tuckahoe, Huntingdon county.

DESCRIPTION.

Pipe ore; the stems or pipes large; portions of the surface iridescent.

COMPOSITION IN 100 PARTS :

Peroxide of iron,	....	..	....	..	86.91
Alumina,	..	..	..	..	0.22
Silica and insoluble matter,	..	....	..	..	1.93
Water,	..	..	....	..	10.44
					<hr/>
					99.50
					<hr/>

This specimen contains 60.26 per cent. metallic iron.

IRON ORE from one mile South-West of Bell's Furnace, Tuckahoe, Huntingdon county. This ore seems to be derived from F. VII.

DESCRIPTION.

Color, a dark chocolate brown; lustre somewhat resinous. This variety is said to make a brittle iron.

COMPOSITION IN 100 PARTS :

Peroxide of iron,	....	..	....	..	73.28
Oxide of Manganese,	..	....	....	..	a trace
Alumina,	..	..	..	..	5.52
Silica and insoluble matter,	....	..	..	..	12.88
Water,	..	....	..	....	9.38
					<hr/>
					101.06
					<hr/>

This specimen contains 50.81 per cent. metallic iron.

SECTION VII.

Analyses of Iron Ores from Formation VIII.

IRON ORE from the Synclinal Axis, Nevey's Bank, one and a half miles South-east of Newton Hamilton, Lewistown Valley, Huntingdon county. This ore occurs near the contact of Fs. VII. and VIII.

DESCRIPTION.

Structure imperfectly laminated; somewhat cellular; color, dull mottled brown; highly silicious.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	..	..	20.5
Alumina,	....	....	....	4.6
Peroxide of iron,	....	....	...	65.4
Manganese,	....	..	..	a trace
Water,	....	....	....	9.0
Loss,	....	....	....	0.5
				<hr/>
				100.0
				<hr/>

This specimen contains 45.78 per cent. metallic iron.

IRON ORE from the Synclinal Axis; half a mile West of Brookland Furnace, (Walter's Bank,) Lewistown Valley, Mifflin county. Occurs near the contact of Fs. VII. and VIII.

DESCRIPTION.

Structure, hematitic; color, rich chocolate brown; surface velvet like, and occasionally brilliantly iridescent.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	...	....	18.80
Alumina,	....	..	5.80
Peroxide of iron,	....	....	66.00
Water,	....	..	9.00
Manganese,	....	..	a trace
			<hr/>
			99.60
			<hr/>

This specimen contains 46.2 per cent. metallic iron.

IRON ORE from Warren Ore Bank, North-West side of Synclinal Axis of Little Cove, and a half a mile North-West of the Iron Work, Franklin county.

DESCRIPTION.

Structure, hollow or shell-like ; color, dark brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	...	...	...	18.8
Alumina,	....	....	...	a trace
Peroxide of iron,	.	.	..	67.6
Manganese,	..	..	..	a trace
Water,	...	...	..	12.7
Loss,	....	..	....	0.9
				<hr/>
				100.0
				<hr/>

This specimen contains 47.32 per cent. metallic iron.

IRON ORE from Brown's Furnace, Little Cove, Franklin county.

DESCRIPTION.

Compact ; nodular ; color, bluish grey. Occurs as a regular stratum in the lower beds of F. VIII. in various places.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	...	....	17.00
Alumina,	..	..	1.50
Protoxide of iron,	....	....	50.00
Carbonic acid,	..	..	30.55
Water,	..	....	1.00
			<hr/>
			100.05
			<hr/>

This specimen contains 38.8 per cent metallic iron. This valuable ore has never been worked, though it is obviously rich enough and sufficiently pure. The quantity of it in many of the synclinal basins of F. VIII., where it often forms a regular seam, is inexhaustible.

SECTION VIII.

Analysis of Iron Ores from Formations IX.

IRON ORE from Larry's Creek, Lycoming county, (near the contact of F. VIII, and F. IX.

DESCRIPTION.

Purplish brown; streak red; structure stratified or laminated; consists of flattish granules; fossiliferous; somewhat sandy.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	32.30
Alumina,	....	..	3.00
Peroxide of iron,	..	....	61.20
Carbonate of lime,	..	....	1.30
Water,	....	..	2.20
			<hr/>
			100.00
			<hr/>

This specimen contains 42.84 per cent. metallic iron. It does not manifest, by analysis, the faintest trace of manganese.

IRON ORE from the north-west side of Big Scrub Bridge, and two and a half miles south-west of the turnpike. Occurs near the contact of F. IX. F. X.

DESCRIPTION.

Compact, fibrous, hematitic; color, dark mahogany brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	2.85
Alumina,	..	....	a trace
Peroxide of iron,	....	..	84.54
Water,	....	..	12.00
			<hr/>
			99.39
			<hr/>

This specimen contains 59.17 per cent. metallic iron.

SECTION IX.

Analysis of Iron Ores from formation XI.

IRON ORE from Hopewell Furnace, from old bank, on north side of the river. The best kind used from this opening, occurs near the contact of F. X. and F. XI.

DESCRIPTION.

Nodular, geodiferous; surface coated with a pinkish deposit—interiorly by a velvet like oxide.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	..	32.1
Alumina,	..	....	..	2.5
Peroxide of iron,	....	..	....	60.0
Lime,	..	....	..	0.4
Manganese,	..	....	..	a trace
Water,	....	..	....	4.5
Loss,	..	....	..	0.4
				<hr/>
				100.0
				<hr/>

This specimen contains 42.0 per cent. metallic iron.

IRON ORE from a vein in a tunnel in Terrace mountain, Hopewell Furnace. Occurs near the contact of F. X. and F. XI.

DESCRIPTION.

Massive, compact; fracture, coincidal; lustre, dull; color, chocolate brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	..	2.30
Alumina,	..	....	..	a trace.
Manganese,	....	..	..	a trace
Peroxide of iron,	....	..	....	84.00
Water,	..	....	..	13.50
Loss,	....	..	....	0.20
				<hr/>
				100.00
				<hr/>

This specimen contains 58.8 per cent. metallic iron.

IRON ORE from Ralston, Lycoming county, (upper part of the bed.)

DESCRIPTION.

Spathose ; texture, somewhat laminated ; siliceous ; color, ash grey.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	28.80
Alumina,	1.00
Protoxide of iron,	41.22
Lime,	0.50
Carbonic acid,	24.00
Water,	4.28
Loss,	0.5
	<hr/>
	100.00
	<hr/>

This specimen contains 32.06 per cent. metallic iron.

IRON ORE from the upper part of a bed in West Hill, Johnson's creek Blossburg.

DESCRIPTION.

Spathose ; texture somewhat laminated ; color, light grey, with faint pink hue ; highly siliceous.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	66.80
Alumina,	0.50
Protoxide of iron,	18.54
Carbonic acid,	11.30
Manganese,	a trace.
Water,	2.56
Loss,	0.30
	<hr/>
	100.00
	<hr/>

This specimen contains only 14.42 per cent. metallic iron.

IRON ORE from the bed at Astonville, Frozen run, Lycoming county.

DESCRIPTION.

Light grey, mottled ; consists of minutely chrystalline carbonate of iron ; of a pinkish yellow color, sometimes velvet like.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	....	28.7
Alumina, ....	..	....	0.8
Protoxide of iron,	....	..	42.2
Carbonate of lime,	....	..	0.6
Carbonic acid	..	....	25.8
Water,	..	...	1.5
			<hr/>
			99.6
			<hr/>

This specimen contains 32.8 per cent. metallic iron.

IRON ORE from the lower band of Red Shale, F. XI., Farrandsville,
Lycoming county.

DESCRIPTION.

Color, purplish red; compact dense, nodular, and very slightly crystalline.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	....	25.6
Alumina, ..	....	..	3.6
Peroxide of iron, ..	....	..	68.4
Carbonic acid and water,	..	....	2.0
Lime, ....	..	....	a trace
			<hr/>
			99.6
			<hr/>

This specimen contains 47.88 per cent. metallic iron.

SECTION X.

Analyses of Iron Ores from the Coal Measures of F. XIII., (Anthracite Coal Region.)

IRON ORE from Pottsville, from a bed of huge balls, in a tunnel running north from the Gate vein.

DESCRIPTION.

Texture compact, and close grained; fracture, slightly conchoidal; color, slate blue; feel, slightly unctuous; breaks into irregular shaped masses, which are covered at the surface, of a contact with thin plates of white silicious matter.

COMPOSITION IN 100 PARTS :

Carbonate of iron,	....	..	....	80.85
Carbonate of lime,	....	..	....	1.00
Carbonate of Magnesia	....	..	....	3.86
Alumina,	..	....	..	2.06
Silica and insoluble matter,	..	....		9.08
Carbonaceous matter,	..	....	..	1.02
Water,	....	..	....	2.00
				<hr/>
				99.87

This specimen contains 39.09 per cent. metallic iron.

IRON ORE from the tunnel of the North American Works, Pottsville.

DESCRIPTION.

Compact ; texture, rather coarse grained ; feel, unctious ; interspersed with iridescent spots of iron Pyrites.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	...	50.80
Alumina,	..	...	2.80
Carbonate of iron,	....	..	39.82
Carbonate of lime,	....	..	1.00
Carbonate of Magnesia,	..	....	2.35
Manganese,	..	....	a trace
Sulphur,	..	....	a trace
Water,	..	....	2.00
Carbonaceous matter,	....	..	1.20
			<hr/>
			99.97

This specimen contains 19.21 per cent. metallic iron.

IRON ORE from the outcrop of a bed next below the rabbit hole vein, Eyre tract, Pottsville.

DESCRIPTION.

Occurs in oval lenticular shaped masses ; external structure, concentric ; color, dull brown ; internally, slate blue.

COMPOSITION IN 100 PARTS :

Carbonate of iron,	....	..	....	65.30
Oxide of manganese,	..	....	..	a trace
Alumina,	..	....	..	3.20
Carbonate of lime,	....	..	....	1.50
Carbonate of Magnesia,	....	..	....	1.60
Silica and insoluble matter,	..	....	..	25.00
Organic matter,	..	....	..	1.22
Water,	..	....	..	1.50
				<hr/>
				99.32

This specimen contains 32.6 per cent. metallic iron,

IRON ORE from the outcrop of a bed found ten feet below a seam of coal, opened by B. Patterson, Pottsville.

DESCRIPTION.

Irregularly rounded mass, very hard; color, light slate blue; highly siliceous.

COMPOSITION IN 100 PARTS:

Carbonate of iron,	....	..	....	67.80
Carbonate of manganese,	..	....	..	1.00
Carbonate of lime,	....	..	....	0.39
Carbonate of magnesia,	..	...	..	a trace.
Alumina,	..	....	..	1.30
Silica and insoluble matter,	..	....	..	29.00
Water,	....	..	....	0.50
				<hr/>
				99.99
				<hr/>

This specimen contains 33.9 per cent. metallic iron.

IRON ORE from M'Carty's Tunnel, Pottsville.

DESCRIPTION.

Irregular rounded mass, somewhat micaceous; feel, slightly unctuous; color slate blue, and in the centre a little iridescent.

COMPOSITION IN 100 PARTS:

Peroxide of iron,	..	....	....	..	19.36
Carbonate of iron	....	....	....		26.02
Manganese,	..	..	....	....	a trace
Alumina,	..	..	....	..	2.08
Carbonate of lime,	....	....	....		0.07
Carbonate of Magnesia	...	...	..		4.04
Silica and insoluble matter,	..	...	..		46.40
Water,	..	....	....	....	1.00
					<hr/>
					98.97
					<hr/>

This specimen contains 26.39 per cent. metallic iron.

IRON ORE from one of several bands near the end of Mann and Williams' Tunnel, Pottsville.

DESCRIPTION.

Texture, compact and close grained; aspect, earthy; fracture, slaty; surface, smooth; feel, unctuous; color, slate blue.

COMPOSITION IN 100 PARTS :

Carbonate of iron,	....	....	....	72.00
Manganese,	..	....	..	a trace
Carbonate of lime,	....	....	....	2.08
Carbonate of magnesia,	..	..	....	1.52
Alumina,	....	..	....	1.60
Silica and insoluble matter,	....	..	....	21.50
Carbonaceous matter,	....	..	....	1.00
Sulphur,	..	..	..	a trace
Water,	..	....	..	3.0
				<hr/>
				100.00
				<hr/>

This specimen contains 36 per cent. metallic iron.

IRON ORE from a bed south of the false Salem vein, Guinea Hill, on Market street, Pottsville.

DESCRIPTION.

Irregular nodular mass, compact interiorly ; on surface, brittle and somewhat laminated; color interior, slate blue; surface, ochreous brown; aspect, earthy and micaceous.

COMPOSITION IN 100 PARTS :

Peroxide and carbonate of iron,	..	..	56.20
Alumina,	..	..	2.80
Manganese,	..	....	a trace
Carbonate of lime,	....	....	a trace
Carbonate of magnesia,	...	...	0.8
Silica and insoluble matter,	..	....	39.30
Carbonaceous matter,	..	....	0.50
Water,	....	..	0.20
			<hr/>
			99.80
			<hr/>

The proportion of metallic iron in this specimen is 32.48 per cent.

IRON ORE from a bed behind a barn on Guinea Hill, Pottsville.

DESCRIPTION.

Similar to the above, except that the external portion is more distinctly laminated.

COMPOSITION IN 100 PARTS :

Peroxide and carbanate of iron,	..	...	63.3
Alumina,	..	...	2.8
Lime,	....	...	a trace
Carbonate of magnesia,	....	..	1.4
Silica and insoluble matter,	....	....	32.0
Water,	....	..	0.4
			<hr/>
			99.9
			<hr/>

This specimen contains 30.66 per cent. metallic iron.

IRON ORE from Pottsville, from a collection of veins near the north end of Mann and Williams' tunnel.

DESCRIPTION.

Texture, compact and close grained; aspect, earthy; fracture, slightly conchoidal; feel, little unctuous; color, slate blue.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	15.00
Alumina,	2.60
Peroxide and carbonate of iron,	79.20
Lime,	a trace.
Magnesia,	a trace.
Manganese,	a trace.
Water,	1.60
Carbonaceous matter,	1.30
	<hr/>
	99.70

This specimen contains 2.84 per cent. metallic iron.

IRON ORE from a bed behind a barn on Guinea hill, north of the false Salem; vein, fourteen inches thick.—Pottsville.

DESCRIPTION.

Texture, compact; close grained; fracture, slightly conchoidal; aspect, earthy; color, slate blue; feel, smooth and unctuous.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	....	..	21.00
Alumina,	....	..	1.60
Peroxide of iron,	..	....	44.64
Insoluble carbonaceous matter,	..	....	1.00
Lime,	....	..	0.70
Magnesia,	....	..	0.70
Carbonic acid,	..	....	27.05
Water,	..	....	1.40
			<hr/>
			99.54
			<hr/>

This specimen contains 34.72 per cent. metallic iron.

Iron Ores of the Bituminous Coal Measures

IRON ORE from the "Deal Bank," one mile south of Shippenville,
Clarion county. (Buhr-stone ore.)

DESCRIPTION.

Hematitic; cellular; interior cells coated with small crystalline oxide; color, purple brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	....	..	2.81
Alumina,	....	..	a trace.
Peroxide of iron,	....	..	83.00
Sesquioxide of manganese,	..	....	2 00
Water,	..	....	12.50
			<hr/>
			100.31
			<hr/>

The proportion of metallic iron in this specimen, is 58.1 per cent.

IRON ORE from the land of Mr. M'Ginnis, used at Porterfield's Furnace, Clarion county. (Buhr-stone ore.)

DESCRIPTION.

Hematic, slightly cellular; color, purplish brown.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	..	5.30
Alumina,	...	....	a trace.
Peroxide of iron,	....	..	79.20
Sesquioxide of manganese,	....	..	1.00
Water,	....	..	14.00
			<hr/>
			99.50
			<hr/>

This specimen contains 55.44 per cent. metallic iron.

IRON ORE from the land of Mr. M'Ginnis, used at Porterfield's Furnace, Clarion county. (Buhr-stone ore.)

DESCRIPTION.

Irregular shaped: nodular, with a dense nucleus enveloped by a laminated and concentric crust; color, reddish brown; structure, somewhat oolitic.

COMPOSITION IN 100 PARTS :

Silica,	..	..	....	..	...	21.50
Alumina,	..	....	..	..	..	0.70
Peroxide of iron,	....	....	....	....	....	45.04
Carbonic acid,	....	..	....	..	...	25.30
Carbonate of lime,	....	....	....	....	....	1.78
Carbonate of manganese,	..	..	..	..	..	1.00
Water,	....	....	..	..	..	4.00
						<hr/>
						99.68
						<hr/>

This specimen contains 35.03 per cent. metallic iron.

IRON ORE from Rockland Furnace, Venango county, (Nodular, or Ball ore.)

DESCRIPTION.

Texture, hard and compact; nodular; fracture, somewhat conchoidal; color, dark slate blue—externally brown.

COMPOSITION IN 100 PARTS :

Carbonate of iron,	....	..	....	79.90
Carbonate of lime,	....	....	....	2.60
Oxide manganese,	....	..	..	.05
Alumina,	..	..	....	.50
Silica and insoluble matter,	....	....		14.80
Organic matter,	..	..	....	a trace
Water,	....	..	....	2.00
				<hr/>
				99.85

This specimen contains 38.05 per cent. metallic iron.

IRON ORE from the land of Joseph Kutcher, Clarion county, (Buhrstone ore.)

DESCRIPTION.

Spathose; texture, compact; fracture, conchoidal; color, bluish grey.

COMPOSITION IN 100 PARTS :

Carbonate of iron,	....	....	....	76.30
Alumina,	....	....	....	1.00
Carbonate of lime,	....	..	....	6.00
Silica and insoluble matter,	..	...	..	13.30
Oxide of manganese,	..	..	....	.50
Water,	..	..	....	2.00
				<hr/>
				99.10
				<hr/>

The proportion of metallic iron in this specimen, is 59.03 per cent.

Iron Ore from the land of Jos. Kucher, Clarion co. (Buhr, stone ore.)

DESCRIPTION.

Texture, soft and porous; fracture, irregular; aspect, earthy; color, dull red, speckled with white spots.

COMPOSITION IN 100 PARTS :

Peroxide of iron, and	....	....	}	87.04
Carbonate of iron,	....	....
Alumina,	....	.....	....	.05
Carbonate of lime,	....	...	....	4.06
Silica and insoluble matter,	....	....	....	5.08
Water,	....	....	..	1.05
				<hr/>
				99.08

This specimen contains 54.14 per cent metallic iron.

IRON ORE from Lucinda Furnace, (Huges's) Clarion county, (Buhr-stone ore.)

DESCRIPTION.

Structure, geodiferous, cellular; walls composed of imperfectly crystallized hæmatite; interior of cells coated with a firm ochereous deposit; color, chesnut brown.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	..	....	4.80
Alumina,	..	....	0.54
Peroxide of iron,	....	..	78.22
Sesquioxide of manganese,	..	....	1.50
Water,	....	..	14.20
			<hr/>
			99.29

This specimen contains 54.75 per cent. of metallic iron.

IRON ORE from Phipp's furnace, Scrub Grass township, Venango co. (ball ore.)

DESCRIPTION.

Texture, hard, compact; fracture conchoidal; somewhat nodular; interior, slate blue—outside brown.

COMPOSITION IN 100 PARTS :

Peroxide of iron and carbonate of iron,	..	96.00
Manganese,	..	a trace.
Alumina;	..	0.50
Lime,	...	a trace.
Silica and insoluble matter,	..	2.10
Organic matter,	....	a trace.
Water,	..	1.00
		<hr/>
		99.60

This specimen contains 41.3 per cent. metallic iron.

IRON ORE from Hickory Furnace, Butler county, (Buhr-stone ore.)**DESCRIPTION.**

Nodular, cellular; walls of cells composed of chrystalized hematite and lined with a rich velvet like oxide; color, bright chesnut brown; surface coated with a thin argillaceous crust.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	20.0
Alumina,	..	....	1.8
Peroxide of iron,	....	..	65.2
Peroxide of manganese,	.	....	1.5
Water,	..	....	11.0
			<hr/>
			99.5
			<hr/>

The amount of metallic iron in this specimen, is 45.64 per cent.

IRON ORE from Madison Furnace, Clarion county, (Buhr-stone ore.)**DESCRIPTION.**

Externally cellular; interior compact: color, mass dull brown—of surface, ocherous; aspect siliceous.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	7.7
Alumina,	..	....	3.6
Peroxide of iron,	..	....	76.1
Lime and magnesia,	..	....	traces.
Water,	..	....	12.5
			<hr/>
			99.9
			<hr/>

This specimen contains 53.27 per cent. metallic iron.

BOG IRON ORE from Smullen's Furnace, Venango county.**DESCRIPTION.**

Soft, earthy, pulverulent; color, rich brown yellow; finely powdered, color more brilliant—Bog ore.

COMPOSITION IN 100 PARTS:

Silica and insoluble matter,	..	....	3.8
Alumina,	..	....	a trace.
Peroxide of iron	....	..	80.12
Oxide of manganese,	..	....	0.50
Water,	....	..	13.00
Organic matter,	..	....	2.00
			<hr/>
			99.42
			<hr/>

This specimen contains 56.07 per cent. metallic iron.

BOG IRON ORE from Hickory Furnace, from M'Cullum's bank, Butler County.

DESCRIPTION.

Brittle, earthy mass; containing thin plates of imperfectly crystallized hæmatite; color, bright cinnamon brown—Bog ore.

COMPOSITION IN 100 PARTS :

Silica and insoluble matter,	4.8
Alumina,	a trace.
Peroxide of iron,	78.6
Oxide of manganese,	0.4
Organic matter	2.0
Water,	14.0
	<hr/>
	99.8
	<hr/>

This specimen contains 55.02 per cent. metallic iron.

IRON ORE from Bear Creek Hill, Blossburg, Tioga county.

DESCRIPTION.

Color, mottled, reddish and grey; structure, compact, granular, oolitic; in some parts crystalline.

COMPOSITION IN 100 PARTS :

Carbonate of iron,	44.79
Peroxide of iron,	8.41
Carbonate of manganese,	0.88
Carbonate of magnesia and a little manganese	1.99
Alumina,	0.34
Silica and insoluble matter,	37.28
Water,	6.23
	<hr/>
	99.92
	<hr/>

The proportion of metallic iron in this specimen is 27.05 per cent.

IRON ORE from a part of the same bed with the above—Blossburg.

DESCRIPTION.

Occurs in elongated nodules; color, dingy brown externally—ochrey within; breaks by concentric layers; soft and somewhat earthy; speckled; showing a tendency to an oolitic structure.

COMPOSITION IN 100 PARTS :

Peroxide of iron,	26.69
Oxide of manganese,	0.32
Magnesia with a minute trace of manganese, ..	0.44
Alumina,	1.88
Silica and insoluble matter,	59.36
Water,	10.52
	<hr/>
	99.21
	<hr/>

The proportion of metallic iron in this specimen, which is a fair average of the class of ores to which it belongs, is only 18.51 per cent.

SECTION XI.

Analyses of Iron Ores from the Middle Secondary Red Sandstone Formation.

MAGNETIC IRON ORE from Daniel Feglie's mine, Boyerstown, Colebrookdale township, Berks county.

DESCRIPTION.

Color, dark dull grey, approaching black, with glimmering crystalline points; powder, black; shows a very slight effervescence by an acid; contains some green chloritic clay; acts on the magnetic needle; occurs in a vein in the red shale, near its contact with the primary rocks of the South Mountains.

COMPOSITION IN 100 PARTS :

Magnetic oxide of iron,	86.67
Alumina,	1.36
Carbonate of lime,	0.80
Magnesia,	2.60
Silica and insoluble matter,	7.72
Water,	0.80
	<hr/>
	99.95
	<hr/>

The proportion of metallic iron in this ore is 62.22 per cent

MAGNETIC IRON ORE from the Warwick mine, near Morgantown,
Berks county.

DESCRIPTION.

Color, black; lustre, metallic, but rather dull; contains numerous cavities, the walls of which are coated with ferruginous and talcose matter, and with perfect crystals of oxydulated iron, in rhombic dodecahedron's the ore possesses magnetic polarity.

COMPOSITION IN 100 PARTS:

Magnetic oxide of iron,	..	....	..	97.61
Alumina,	..	...	..	a trace.
Silica and insoluble matter	..	....	..	1.69
				<hr/>
				99.30
				<hr/>

The proportion of metallic iron in this specimen, is 70.19 per cent. No titanic acid could be detected in it.

MAGNETIC IRON ORE from Cornwall mine, Lebanon county.

DESCRIPTION.

Nearly black; aspect dull, with brilliant points; somewhat cellular; the little cavities containing small octohedral crystals of the magnetic oxide. They contain also a whitish asbestiform mineral. The ore possesses magnetic polarity. The water which it shows by analysis, is probably, only hygrometric.

COMPOSITION IN 100 PARTS:

Magnetic oxide of iron,	..	....	..	97.99
Alumina,	..	....	..	0.84
Silica and insoluble matter,	..	....	..	0.24
Water, ....	.	....	..	0.12
				<hr/>
				99.19
				<hr/>

This specimen contains 70.34 per cent. metallic iron.

SECTION XII.

Analyses of Cast Irons.

CAST IRON, manufactured from the fossiliferous ore of Montours Ridge,
near Bloomsburg, Columbia county, at Esther Furnace.

DESCRIPTION.

A dull grey soft iron, uniformly and rather coarsely crystalline.

COMPOSITION IN 100 PARTS :

Pure iron,	..	....	..	....	96.100
Silicium,	..	....	..	..	0.100
Aluminium,	....	..	....	..	a mere trace.
Manganese,	..	....	..	....	0.224
Carbon,	....	..	....	....	3.500
					<hr/>
					99.924
					<hr/>

CAST IRON manufactured at M'Nichols Furnace, near Kittaning, from the Buhr-stone ore of Armstrong county.

DESCRIPTION

A soft grey metal, of an uniform, well developed crystalline grain.

COMPOSITION IN 100 PARTS :

Pure iron,	..	....	.	....	..	89.63
Silicium,	.	....	..	....		5.44
Aluminium,		....	..	....	..	0.65
Manganese,	..	....	..	....		0.12
Carbon,	..	...	..	....	..	3.90
Phos. and sulphur,		....	..	....		traces.
						<hr/>
						99.74
						<hr/>

MISCELLANEOUS SUBSTANCES.

Analysis of a *Cadmia*, or incrustation on the in-walls of Mary Ann Furnace, belonging to Whitehill and Ellis, Cumberland county.

COMPOSITION IN 100 PARTS :

Oxide of zinc,	...	...	..	..	92.48
Oxide of lead,	....	....	....	..	6.48
Peroxide of iron,	..	..	....	..	1.00
Carbonaceous matter,	..	..	....		a trace
					<hr/>
					99.96
					<hr/>

It manifested scarcely a trace of either sulphur or manganese, nor could oxide of cadmium or any other metallic matter, except those shown above, be detected. Incrustations of this nature are not unfrequent in furnaces, and when originally noticed, received the name of *cadmia*.

CONCLUSION.

Besides the extensive suite of iron ores here presented, we have analysed an equally numerous series of Coals and Limestones. The relation which these several substances mutually possess, as the three great essentials in the manufacture of iron, renders the precise determination of their chemical nature in each instance, a point of high practical importance to a leading branch of our domestic industry. I am, therefore, conducting a systematic chemical investigation, into the properties of all our ores, fuels and varieties of flux employed, intending to extend the inquiry to the several kinds of cast and malleable iron which our State produces. As much preliminary labor is to be encountered before this portion of our researches will be in a condition for publication, I shall postpone all general conclusions connected with the several circumstances affecting the quality and quantity of iron afforded by different ores, until the opportunity is furnished me for discussing this subject at large, in the pages of my final report. Let me, in the mean while, however, allude to one obvious and important fact, the discrepancy in the amount of iron here shown to exist in our ores, compared with that which they produce when smelted by the methods in common use. With a few exceptions, the charcoal furnaces of this State do not get from the ore more than about 40 per cent. metallic iron, and many, not more than 33 per cent.—whereas, it appears from the foregoing analyses, that a large class of the ores employed, contain more than 50 per cent. of metal. This serious waste is mainly attributable, I conceive, to the use of furnaces of too small a size, to too weak a species of fuel, but especially, to too feeble a blast: circumstances all tending to cause a heat insufficient for the thorough reduction of the ore.

Respectfully submitted,

HENRY D. ROGERS.

PHILADELPHIA, *February*, 1 1840.

